POWER PLANT ENGINEERING

GENERATION - TRANSMISSION - DISTRIBUTION - UTILIZATION

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CHAINED LIGHTNING

THE TERM, CHAINED LIGHTNING, we always supposed, was a purely figurative expression suggested by man's control over electrical forces, but this photograph almost caused us to change our opinion and to accept the term literally. For this picture, as will be noted, most clearly shows a chain and what it is for if not to keep those wispy crackling streamers in leash? We may be wrong, however; Westinghouse, from whom we received the photograph, tells us that it shows a high voltage test on porcelain insulator bushings at their Derry, Pa., works. These flashovers at 200,000 volts are as severe as they are impressive and the insulators that withstand them successfully are well constituted to cope with the voltage surges met with in commercial service. Such tests are a highly essential part of modern manufacturing methods and are naturally an important factor in the determination of final design.

WITH THE EDITORS

What Price Government?

MOST MEN want above all else a sense of security and certainty about the future. Social security legislation has been advocated on that basis, and present laws have been formulated to accomplish that purpose, the Government to act as banker and guarantor. Success of any such plan relies on the financial stability and integrity of the Government, hence that becomes of prime interest.

Factors that enter are the ability to meet obligations, maintenance of law and order, continued production by industry so that Government may have sources of revenue. If indebtedness increases beyond the ability to pay, bankruptcy looms, for an individual, a corporation or a government. Ability to pay depends on resources in hand and prospects of future income. Financial stability of any institution is based on belief in its ability to pay its obligations. It may be weakened by piling up of indebtedness or by reduction in assets or in probable future income.

For the Government, increase in indebtedness continues, with no signs of slowing down. For January, 1937, the increase was $347,500,000, or $13,900,000 for each working day. This was $119,400,000 larger than for January 1936, despite the improvement in business, increase in income tax receipts and better employment conditions. Treasury expenditures for January 1937 were $162,300,000 higher than for the same month in 1936 or at a rate of $2,000,000,000 more a year. Yet there are proposals to further increase government expense by starting a plan for large public works and publicly owned utilities, by providing a permanent relief program, and by establishing methods of strict regulation and control of industry.

No need for increased taxes has been proclaimed but it is a bit difficult to reconcile this with the present and proposed increases in expenditure, and with the movement toward increased cost of production by reduced hours of working. If revenue is to be increased, how is it to be raised? Taxation can only take part of the wealth annually produced or take part of that which already exists. In the former case it comes out of the income of workers; in the latter case, it is taken from what workers have saved and invested. In the one case it tends to reduce the standard of living, a standard which all are desirous of having maintained or raised; in the other case, it reduces the funds that have been accumulated as a safeguard of future security to the owners. Moreover capital tax on existing wealth tends to move industry from private to public ownership.

At present, federal, state and local taxes are taking some 25 per cent of the national income. The burden rests on all workers for it results in increased costs of food, rent and clothing, the increase for the last 15 mo. being 8.1 per cent, of which 3.4 per cent has come in the first 3 mo. of 1937. What part of national income can the people pay in taxes without reducing living standard? What increase of taxes on industry will raise costs so that demand for products will diminish and employment be curtailed? How much of national income can Government take without reducing industrial activity and thus reducing wealth production and the sources of government revenue? What price can we afford to pay for government?

As to capital tax and entry of government into control of business, what is the record? What was the result of control of railroads during the war? What of the record of construction of subsistence homes and communities? How has Australia, an essentially government-ownership country, fared? Railroad history and subsistence project costs have often been fully discussed and analyzed. In Australia, 95 per cent of publicly owned industries are in the red and their debts are increasing each year. Either the taxpayers will pay or the creditors will lose. Victoria locomotive works recently ordered locomotives from the Baldwin Works in Philadelphia and they were laid down in Victoria for $8000 less apiece than the cost of building them in the Victoria works, with wages in Philadelphia 40 per cent higher than in Victoria and shipment half way round the world.

What price can we afford to pay for government ownership and operation of industry?

Testing

EQUIPMENT TESTS are ordinarily made for the purpose of checking up guaranteed performance. These tests are often made under ideal conditions and represent the best possible performance of the equipment supplied so that the results are usually better than those possible in every day operation.

As far as the operating department is concerned, however, such tests may be used to good advantage for the purpose of setting a bogey for the operators. This is particularly applicable in the boiler room where the possible boiler efficiencies depend largely upon the care and intelligence of the fireman.

Where possible tests of this kind should be made by an outside disinterested party properly qualified, both by theoretical knowledge and practical experience, for the task and with suitable instruments, properly calibrated and with sufficient helpers. After the tests are made they should be available for use by the operating department. Do not expect the impossible from the operators, however, they need instruments too, good instruments, properly installed, carefully maintained and calibrated.

Which of these is most important is difficult to determine. Good instruments alone are not sufficient. They must be installed properly. After they are installed they must be cleaned, oiled and calibrated occasionally. But even then they are not of much service unless the operators are taught how to use them effectively and then reminded from time to time that operation is being carefully watched.

The Indian Chief was right—when his tribe went out to hunt game he stream-lined his forces by sending them single file through the forest and underbrush. The Indians' method is analogous to modern practice in industrial power plants in that steam at high pressure and superheat is led from the boiler through a maze of turbine blades from which it emerges to find another power duty in a lower pressure unit followed by a final service of cooking or heating and orders to come back to the boiler camp without delay for a new supply of B.t.u.'s. Putting a high hat on an old packing plant has its difficulties but they are not insurmountable, here is one way it has been done.

By Harry P. Dempsey
Consulting Engineer,
Hamburg, N. Y.

MODERN EQUIPMENT For

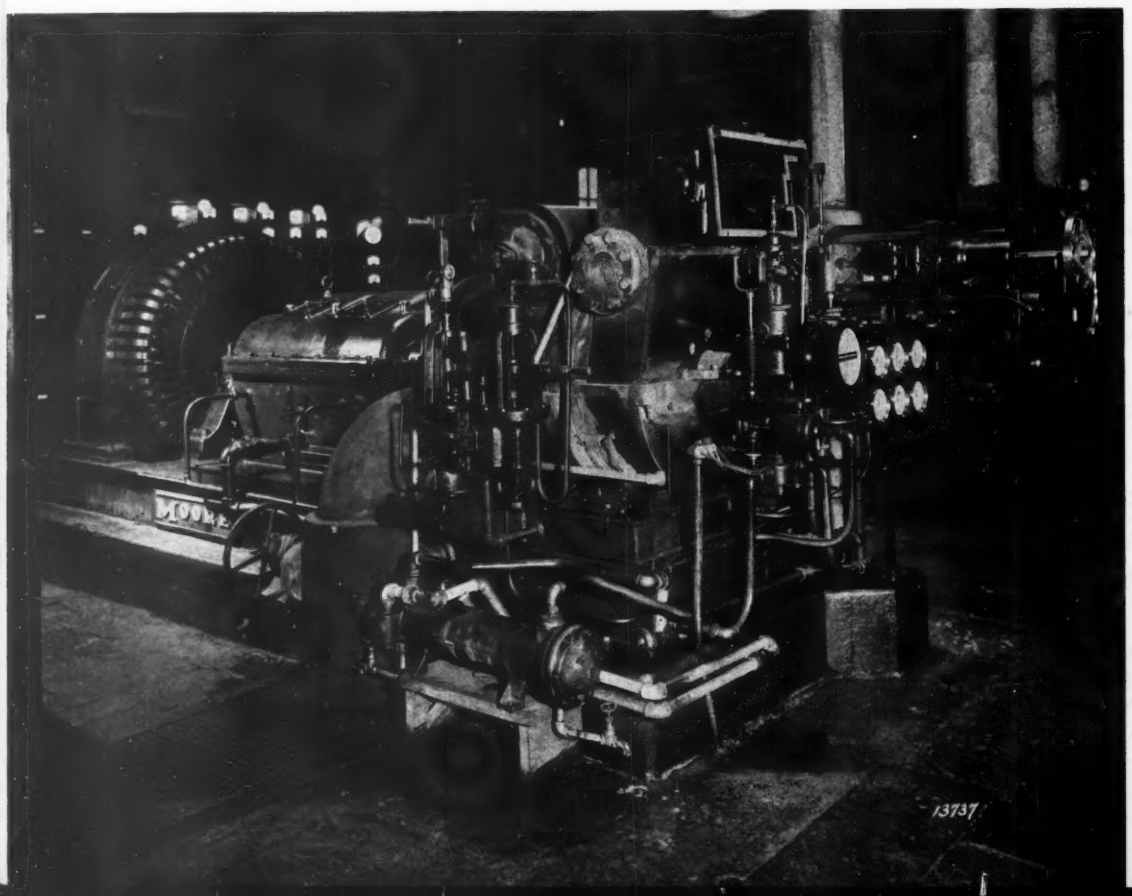


Fig. 1. Two non-condensing, bleeder type turbine generator units now furnish all the electric power and correct pressure process steam for the Dold Packing Plant

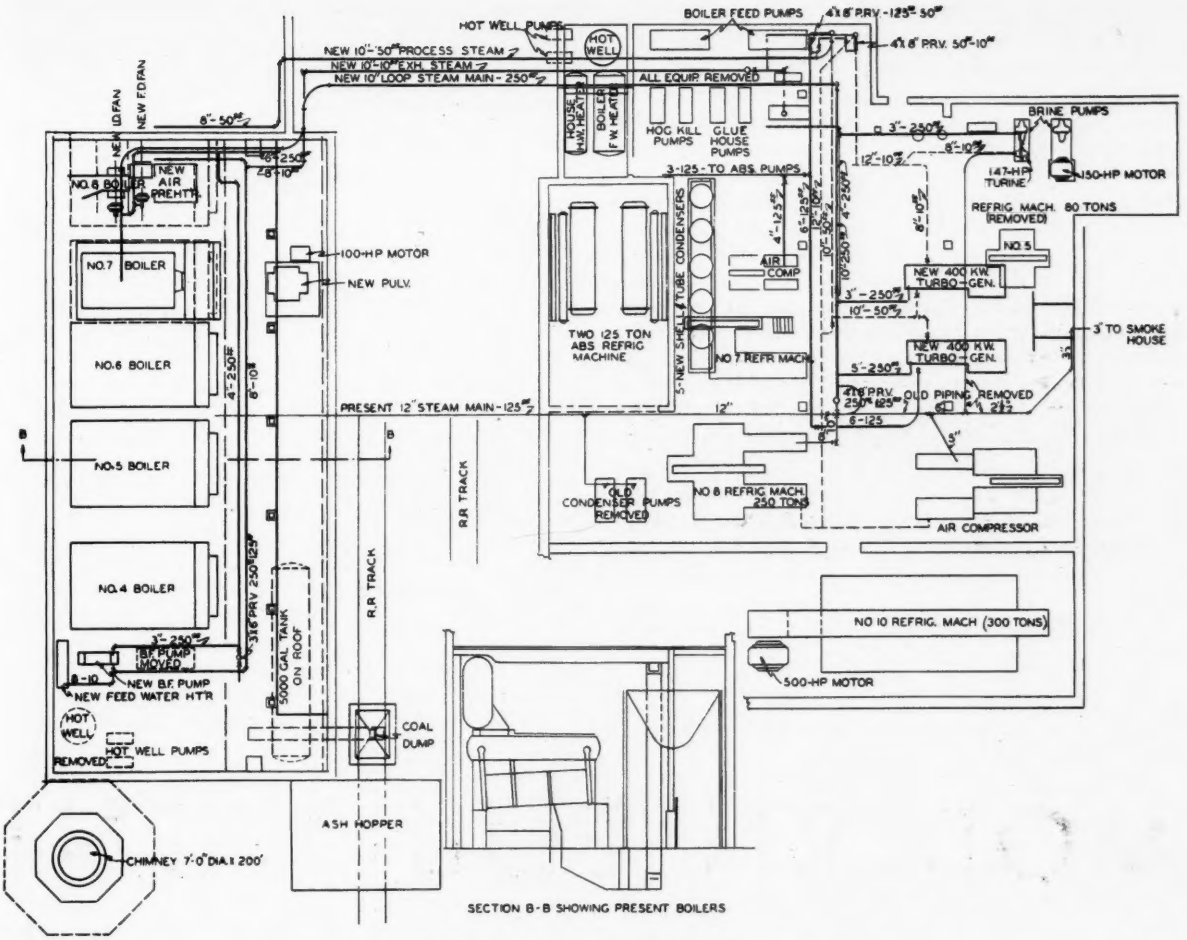


Fig. 2. Plan of plant indicating location of old and new equipment

Jacob Dold Packing Co. Plant

IN 1933, the Jacob Dold Packing Co. decided to make a survey of power and steam conditions in their Buffalo, N. Y., plant. All electric energy, both light and power, was being purchased from the local utility company. The boilers and auxiliary equipment, aside from the general condition, with operating efficiencies low and maintenance on the obsolete equipment high, indicated rehabilitation of the plant was necessary for steam generation. Of course, in addition to power and steam equipment, the survey showed necessary changes in refrigeration, cold and hot water and pumping requirements.

Take a power plant with five 550-hp. horizontal water tube boilers, operating at 125 lb. steam pressure, saturated, and all electric current purchased from a local utility company, and then change the picture by installing one boiler to carry the entire plant, operating at 265 lb. pressure, with 100 deg. superheat, containing water walls and with air preheater, coal pulverizer, forced and induced draft fans and, in the engine room, by installing turbine generator units for the production of all electricity. This transition took place without interruption of service to any department.

Boiler Room

As seen in Fig. 2, the existing boiler house was completely filled with the five horizontal water tube boilers so that it was necessary to remove two of these boilers. It was decided to remove the two oldest boilers in this plant to make way for the installation of new steam generating unit, although these boilers were furthermost from the stack.

If the new steam generating unit had not been decided upon it would have been necessary to put these two old boilers in repair or have allowable steam pressure reduced by the insurance company. New tubes and baffles would have been required, together with repairs to bridge wall and brick settings. An expendi-

ture of between $10,000 and $15,000 would have been necessary and even then the operation would have been comparable to the standards of 20 yr. ago.

Existing equipment remaining in boiler room, of course, includes three of the 550-hp., 125-lb. Keeler boilers with Wetzel stokers, natural draft, with duplex boiler feed pump. The coal and ash conveying systems remain, but were modified to include the new steam generating unit, but exclude the two old boilers removed. The existing overhead coal bunker was partitioned off so the two grades of coal could be handled. The old boilers burn nut size and the new ½-⅜ in. washed pulverized coal. The ash conveyor is the steam type, United Conveyor Corp., the 8-in. pipe shows on boiler section view next to the lower leg of coal conveyor. After the new unit was built the bottom of the furnace was dropped 2 ft. and three ash hoppers and valves were installed in the furnace bottom and connected to the system. Every 4 to 6 hr. this system is turned on and all ash removed by compressed air sweeping to the hoppers. The new unit has been on continuously for over 16 weeks and it is expected to reach a half a year.

New equipment installed in the boiler room consists of—

One Riley-Badenhausen water-tube steam generating unit, continuous rating 67,000 lb. steam per hr., 250 to 275 lb. working pressure and 100 deg. superheat. Riley Stoker Corp.

Heating surface boiler, 4190 sq. ft.
3 water walls, 2000 sq. ft.
Air heater, 6300 sq. ft.

Pulverizer No. 5, Riley Atrita with two 10-in. burners, 100-hp. Westinghouse, 750 r.p.m., 3-phase, 440-v., 25 cycle motor.

Riley superheater.

Riley steel clad insulated setting.

Soot blowers. Vulcan Soot Blower Corp.

Forced draft fan—Buffalo Forge Co. No. 4 SLD—18,000 c.f.m. connected to Moore Steam Turbine S3R—30 hp.

Induced draft fan—Buffalo Forge Co. No. 6 DDHG—33,000 c.f.m. connected to Moore Steam Turbine S2RG—89 hp.

Boiler feed pump—Buffalo Pumps, Inc. Moore Steam Turbine U-2RA—80 hp.

100 lb. automatic crushed coal scale. Richardson Scale Co.

Bailey Meter Co. control panel, 250 lb., 125 lb. and 50 lb. steam flow. Gas and air, temperatures, feedwater, steam pressure and draft gages.

Closed feedwater heater, 67,000 lb. per hr. from 45 deg. to 210 deg. with 10 lb. steam. Patterson-Kelly Co.

Oil removal filter apparatus. The Permutit Co.

Phosphate feed. The Permutit Co.

Swartwout feedwater regulator 3 in. type "C" and 2 in. type "A" Swartwout pump governor. The Swartwout Co.

Feedwater Treatment

Always present is the problem of feedwater. The existing plant was served with a Scaife lime and soda cold process. The water to be treated comes from Lake Erie through City of Buffalo water systems and contains 130 parts of scale forming material per million. By the addition of sodium aluminate the residual hardness was reduced to 18 parts per million. Sodium phosphate was added and the point of application was chosen at the elbow of the feedwater line as it entered No. 1 drum, the low water drum. This point of application is important as the addition of phosphate forms a heavy deposit and would tend to plug up the feedwater line. By the application of sodium phosphate at the water drum, the turbulence in this drum tends to keep the sodium phosphate in suspension. Care should be taken in the design of the internal feed pipe in this drum so as to eliminate plugging up outlets from feedwater lines to the drum. To feed this phosphate in quantities proportional to the load was a new idea. The method universally adopted was to use a pump of small but constant capacity, as the amount of phosphate is small, and this fed constantly regardless of load which is too much phosphate at low loads and too little at high loads.

Having installed a Permutit oil removal filter, the principal of that feed was adapted to the phosphate feed. The Permutit Co. worked out the principal of this unit and it may be designated as a pressure orifice and not a pumping unit. A diagram, together with the principal of operation, is given which better explains this important item for feedwater treatment. The lower or enclosed portion of the tank was designed for

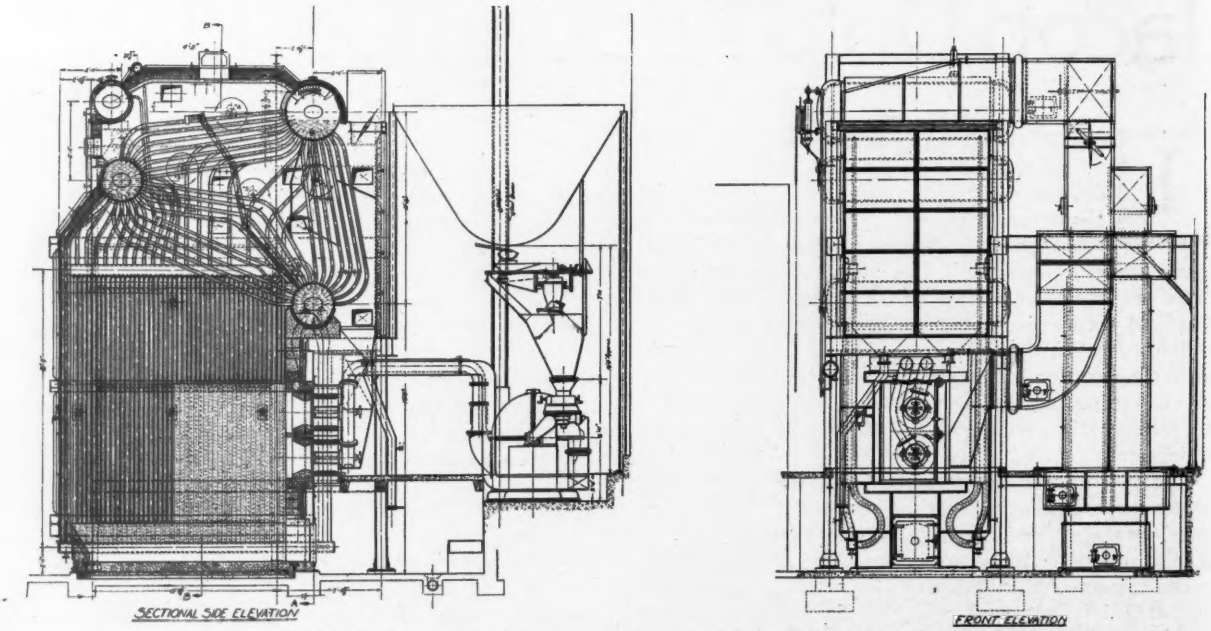


Fig. 3. The new boiler unit is fired with powdered coal and has a rating of 67,000 lb. of steam per hr.

300 lb. pressure, as it was subjected to the boiler pressure. As the boiler load varies from 40,000 lb. per hr. at night to 70,000 lb. per hr. by day, the phosphate is fed automatically in proportion.

Hot and Cold Water Service

All the water for this packing plant is taken from the City of Buffalo water main through four separate metered lines. The cold water for the lower floors throughout the plant is serviced by city pressure, while the upper floors are on pumping service with 85 to 100 lb. pressure at the pumps. This water is pumped either by steam turbine or electric motor driven pumps into an 8000 gal. pressure tank in engine room. The cold water supply is then taken off with a branch leading to the four hot water storage tanks and then through the hot water instantaneous heater for hot water service throughout the plant. The water for the ammonia condensers is a separate unit recirculating 3000 gal. a min. through a Marley cooling pond on the roof of the engine room.

The hot water storage tanks have a capacity of 18,000 gal. with a small heating coil in each, not thermostatically controlled. The instantaneous hot water heater has a capacity of 12,000 gal. of hot water per hr. The piping is so arranged that water may be taken directly through the instantaneous heater or through the storage tanks or in series through both. The idea in design and worked out in practice is that water shall be taken from the 18,000 gal. storage in small hourly amounts to iron off the peak load for steam demand for hot water heating so that at the end of the day the temperature in the storage tank is practically down to city water temperature. Then carrying through the cycle at night is a small amount of heating surface in each storage tank when the load is low, the temperature is again built up when 10 lb. steam is available so that in the morning when the heavy load comes on there is 18,000 gal. of water at 210 deg. ready to be delivered to the plant and starting the 24 hr. cycle again. This cycle is very advantageous as it reduces the steam demand during the peak load condition and uses the 10 lb. exhaust steam at night when the demand otherwise is low.

Engine Room

On drawing Fig. 2, No. 5 steam driven 80-t. ammonia compressor and No. 7 steam driven 120-t. ammonia compressor were removed to allow space for new turbo-generators and shell and tube ammonia condensers. The two boiler feed pumps, the two hog kill pumps, the two glue house pumps, the two house hot water pumps, the two hot well pumps, hot wells and house hot water heater and boiler feedwater heater were all removed and replaced with two pumps, one electric and one steam, for the total water supply for the plant. A new 8000 gal. cold water pressure tank was installed where boiler feed pumps are shown and water is pumped into this tank, a connection taken off for the hot water system so that one pumping does for both hot and cold water. The brine pumps remained in the same location and the 150-hp. motor was changed into 100-hp. retaining the same pump. The turbine drive on the other brine pump was retained, the initial steam being changed from 125 to 250 lb. and a new centrifugal pump purchased for this unit. The two condenser pumps shown to the left of No. 8 compressor were removed and replaced with other available centrifugal pumps with new motors in new location near the new ammonia condensers.

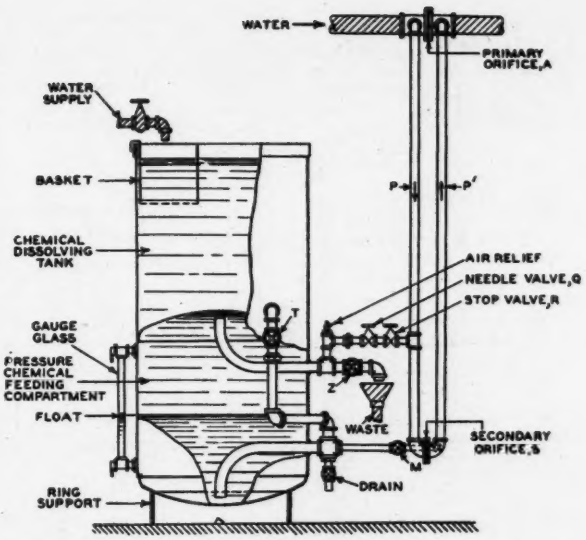


Fig. 4. Diagram of water treating unit with pressure solution feed to show principle of operation

When water passes through the primary orifice "A", a drop in pressure results which is proportionate to the rate of flow. This causes a flow of water through the primary shunt line P and its return P', thus causing a second drop in pressure through the secondary orifice "S" which is also proportionate to the main flow of water. This difference in pressure forces water into the top of the pressure chemical feeding compartment displacing the heavier chemical solution and causing it to flow into the outlet side of the secondary orifice and into the outlet side of the primary orifice.

The 125 lb. pressure steam driven apparatus remaining in the engine room were the No. 8 steam driven Corliss type ammonia compressor and the two steam driven air compressors, the large one used almost constantly and the smaller unit for stand-by service. No. 10 electrically driven ammonia compressor remains to be used for stand-by service only in case of break down.

The new equipment installed in engine room consists of:

Two 400-kw. non-condensing bleeder type Moore-Westinghouse turbo-generator units. Each unit 500 kv-a., 400 kw., 80 per cent power factor, 3-phase, 25-cycle, 480-v. at 750 r.p.m. Westinghouse Electric & Mfg. Co.

No. 1 Turbine type 3SBS, 6 stage, 5000 r.p.m. with reduction gear 12½ in. center, 22 in. face, 5000-750 r.p.m. bleeder, 10,000 lb. per hr. at 50 lb. pressure and exhaust at 10 lb. Moore Steam Turbine Corp.

No. 2 Turbine type 1SB2, 3 stage, 5000 r.p.m. with reduction gear as above, bleeder 25,000 lb. per hr. at 125 lb. pressure and exhaust at 50 lb. Moore Steam Turbine Corp.

Control 4 panel switch gear, three type H-75 kv-a. lighting transformers, 480 to 120-240 v., 1-phase, 25-cycle. General Electric Co.

Two 125-t. absorption refrigeration apparatus operating on 10 lb. steam pressure. Henry Vogt Machine Co.

Five 147-t. vertical type shell and tube ammonia condensers. York Ice Machinery Corp.

Two motor driven condenser water pumps.

Four storage type hot water heaters, Type B. 75 by 240 in., total storage 18,000 gal. with 31 sq. ft. 1 in. tube heating surface each. Patterson-Kelley Co.

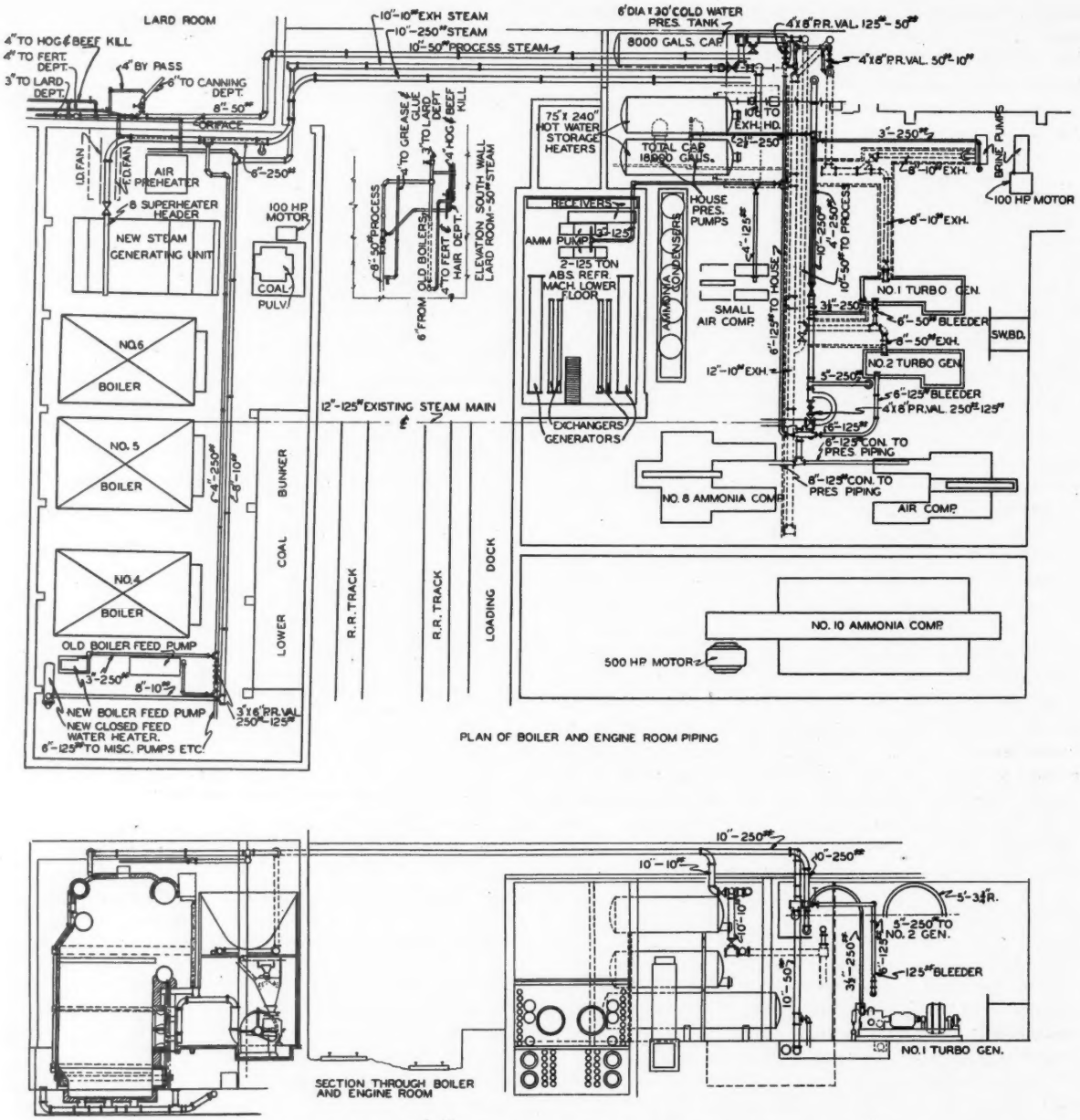


Fig. 5. Plan and elevation of the modernized plant showing the piping connections

One instantaneous hot water heater, Type E. with 278 sq. ft. ¾ in. tubing. Capacity 12,000 g.p.h. from 40 to 180 deg. with 5 lb. steam. Patterson-Kelley Co.

One electric driven cold water pump 6 in. Class S single stage double suction, centrifugal pump 100-hp., 440-v., 3-phase, 25-cycle motor. Buffalo Pumps, Inc.

One turbine driven cold water pump, 5 in. Class SL single stage double suction, centrifugal pump 90-hp. Moore steam turbine drive. Buffalo Pumps, Inc.

One 6 ft. dia. by 30 ft. cold water pressure tank, 8000 gal. capacity.

One brine circulating pump, 6 in. Class SL double suction centrifugal pump with existing turbine operating alternately with existing motor driven brine pump. Buffalo Pumps, Inc.

3000 gal. cooling pond. Marley Co.

Jennings condensation pump.

Piping

A very exhaustive study was made of the piping for this complete plant. The drawings were so studied and designed in the consulting engineer's office as not to interfere with any of the existing apparatus or piping, but connect to it where necessary and in as few places as possible. The piping, valves and fittings were so laid out that all pipe was ordered fabricated and flanged so that no cutting, welding, threading or flanging had to be done in erecting and connecting up the entire piping system. The greatest satisfaction to all was the fact that this fabricating worked out exactly as planned. The piping was furnished by Midwest Piping & Supply Co., Ballwood Division.

Plan, Fig. 5, together with schedules of piping were furnished to contractors for fabrication and prints returned to the engineer's office for checking. All material parts were marked with schedule number, unloaded and taken to the correct location. The pipe-

fitting department, furnished with assembly plan, fabricators' prints and schedules went to work immediately with gaskets and bolted together the various parts. The joints on all 300 lb. piping were "Glo-Back" vanstone type with loose flanges which permitted flexibility if necessary.

Copies of pipe schedule index and schedule A-1 are given here to show the simplicity of the plan.

Some doubt was expressed in the design of the 50 lb. steam piping from the turbo-generators. The turbines are both bleeder type, No. 1 bleeding at 50 lb., exhausting at 10 lb. and No. 2 bleeding at 125 lb., exhausting 50 lb. The 50 lb. bleed and 50 lb. exhaust connected as shown has worked out correctly and no steam has passed from one machine to the other. Fisher check valves and gate valves were provided on all bleed and exhaust lines.

Fly ash containing nearly 50 per cent carbon was found in the base of the stack, so a 2½-in. pipe with hopper was placed in the clean-out of the stack and run back to the boiler at the pulverizer burner. This material, with the material from the ash hoppers in the last pass of the boiler, is again forced by a steam jet, also United Conveyor Co.'s apparatus, back into the boiler, burned and the ash therefrom collected on furnace bottom. This method keeps the stack and hoppers clean and shows an appreciable difference, when in operation, on the amount of coal fed at the time.

All 50 lb. steam derived from the generators in the engine room is returned to the boiler room side of railroad siding, recorded on 50 lb. Bailey flow meter on the boiler room panel and then distributed through separate pipe lines to various departments for process work. Each of these lines is provided with a steam flow orifice and charts produced at various intervals to check the demands of these departments.

Economic Use of Steam

The same amount of steam is used in the plant as was used before this revamping was done, but through manipulation and distribution, more utilization was obtained. The new boiler generates steam at 250 lb., 100 deg. superheat, supplies the forced and induced draft fans, boiler feed pump and house cold water and brine pump turbines. The remainder then goes to both turbo-generators to produce all the electric current for the plant. This entire amount of steam is then bled or exhausted to 125, 50 and 10 lb. lines. The 125 lb. steam supplies No. 8 (250 t.) ammonia compressor, air compressor and some 40 or 50 pumps in the plant. An interesting note in connection with the 125 lb. steam is that initially steam generated 250 lb. produces electricity then at 125 lb. produces 250 t. of refrigeration through No. 8 compressor which exhausts at 12 lb. and produces another 250 t. of refrigeration through the absorption system and returns condensate to the boiler at 210 deg. All 50 lb. steam for processing work is obtained after first passing through the electric generating units. All 10 lb. steam for hot water, feedwater, absorption refrigeration, heating and low pressure process is also obtained after serving to generate electricity and after the utilization of all the 125 lb. steam through apparatus exhausting at 12 lb.

PIPE SCHEDULE INDEX

A-1 250-300 lb. Steam Piping Boiler to Generators.
A-2 250-300 lb. Steam Piping to Brine and House Service Pumps.
A-3 250-300 lb. Steam Piping Soot Blower Piping.
A-4 250-300 lb. Steam Piping to Forced and Ind. Draft Fans and Boiler Feed Pump.
A-5 250-300 Boiler Feedwater Piping.
A-6 Riley Dwgs. 987 X1 x 987 x 52 in. Blowoff and Continuous Blow Down.
A-7 Riley Dwgs. 987 B17—250-300 lb. Water Column and Gage Glass Piping.
A-8 250 lb. to 125 lb. Pressure Reg. Valve and By-Pass.
A-9 Safety Valve Piping from Boilers and from L. P. side of All Pressure Reducing Valves.
B-1 125 lb. Steam Piping Generator No. 2 to Present Main.
B-2 125 lb. Steam Piping to Air Comp. Amm. Pumps and Elev.
B-3 125 lb. to 50 lb. Pressure Reg. Valve and By-Pass.
B-4 125 lb. to Fire Pump.
C-1 50 lb. Steam Piping from Gen. No. 1 and 2 to Ceiling of Lard Dep't. Bldg. K-1.
C-2 50 lb. Steam Piping to Smoke House Bldg. E-2.
C-3 50 lb. to 10 lb. Pressure Reg. Valve and By-Pass.
D-1 10 lb. Exh. Steam Piping in Trench from No. 8 Comp., and Large and Small Air Comp. and House Ser. Pump.
D-2 10 lb. Steam Piping from Gen. No. 1, Brine Pump.
D-3 10 lb. Exh. from present 10 in. main in Eng. Rm. to Boiler Feedwater Heater in Boiler Room.
D-4 10 lb. Exh. Forced and Ind. Draft and Boiler Feed Pumps.
D-5 10 lb. Exh. in Boiler Room, Hot Water Gen. in Eng. Room and Absorption Generators and Amm. Pumps.
DX-1 Miscellaneous.

CONDENSATE AND DRIP PIPING

E-1 250 lb. Drip to Receiver.
E-2 125 lb. Drip to Receiver.
E-3 50 lb. Drip to Receiver.
E-4 10 lb. Drip to Receiver.
E-5 Condens. from Hot Water Heaters to Receiver.
E-6 Condens. from Amm. Generators to Receiver.
E-7 Condens. from Feedwater Heater to Hot Wells.

Gages in Boiler and Engine Room.

F-1 Cold Water Surge Tank to Pumps.
F-2 Cold Water Pumps to Pressure Tank.
F-3 Cold Water Pressure Tank to House System.
F-4 Air Piping to Pressure Tank.
G-1 Cold Water Piping Pressure Tanks to Heaters.
G-2 Hot Water Piping Heaters to House System.

SCHEDULE A-1

300 LB. STEAM PIPING FROM BOILER TO GENERATORS

MAIN 10 IN. ALL FLANGED

Connect on Superheater outlet:
1 10 in. Flg. Globe Valve.
1 pc. 10 in. pipe 7 ft. 1 in. long with 2 ft. 6 in. offset.
1 4 ft. 0 in. rad. bend 10 in. pipe 90 deg.
1 pc. 10 in. pipe 12 ft. 0 in. long to orifice flange for Flow Meter.
1 pc. 10 in. pipe 10 ft. 1 in. long.
1 10 in. x 10 in. x 6 in. flanged Tee.
1 4 ft. 0 in. rad. bend 10 in. pipe 90 deg.
1 pc. 10 in. pipe 3 ft. 1 in. long.
1 4 ft. 0 in. rad. bend 10 in. pipe, approx. 90 deg. plus 10 in. pipe 86 ft. 3½ in.
1 3 ft. 0 in. rad. bend 10 in. pipe—90 deg.
1 pc. 10 in. pipe 6 ft. 8 in. long.
1 4 ft. 0 in. rad. bend 10 in. pipe—90 deg.
1 pc. 10 in. pipe 20 ft. 0 in. long.
1 pc. 10 in. pipe 10 ft. 9 in. long.
1 10 in. Globe Valve Rising Stem.
1 10 in. x 10 in. x 4 in. flanged tee (To Brine & House Service Pumps).
1 10 in. x 10 in. x 3½ in. flanged tee to Generator No. 1.
1 pc. 10 in. pipe 10 ft. 3½ in. long.
1 10 in. x 10 in. x 5 in. flanged tee to Generator No. 2.

TO GENERATOR NO. 1

1 3½ in. Gate Valve O. S. and Y.
1 3½ in. Pipe bend 180 deg. 4 ft. 11½ in. Radius 9 in. tangent to fl. ea. end.
1 pc. 3½ in. pipe 15 ft. 0 in.
1 3½ in. x 3½ in. x 3½ in. Tee (Connect to Throttle Valve)

TO GENERATOR NO. 2

1 5 in. Gate Valve O. S. and Y.
1 5 in. Pipe Bend 180 deg. 5 ft. 3¼ in. Radius 6 in. tangent to fl. each end.
1 pc. 5 in. pipe 15 ft. 1¾ in.
1 5 in. x 5 in. x 5 in. Tee (Connect to Throttle Valve).

Physical Characteristics of Coal

Efficiency of combustion and rate of burning are factors directly affected by the sizing of coal; selection of the proper size for the specific plant involves consideration of stoker and furnace design and load carried on boiler.

By A. BEMENT

AT MANY mines 2-in. screenings are separated into four sizes, as shown in the following tabulation giving size and designation:

Designation	Size, inch
No. 2 or Stone	2 by 1½
No. 3 or Chestnut	1½ by ¾
No. 4 or Pea	¾ by ⅜
No. 5 or Carbon	⅜ by 0

While the coal in these sizes was found to possess a value much greater than could be had from the same coal in the form of screenings, this was not the original reason for the production of these sizes.

In Williamson County, Illinois, coal washing was established some 40 yr. or so ago, for the purpose of improving the quality of the product by the removal of associated impurities. In the washing process adopted the screenings were first separated into the above mentioned sizes and each size washed separately. Now as it would entail additional cost to mix the sizes back together as screenings, the product was marketed in separated condition and each given a name as above stated.

In marketing this prepared coal no value was claimed for its size characteristic, but it was simply sold as washed coal of different size. The user of such sized coal discovered that it gave a performance very much superior to that possible with the same coal in the form of screenings, and this was generally attributed to its washed condition.

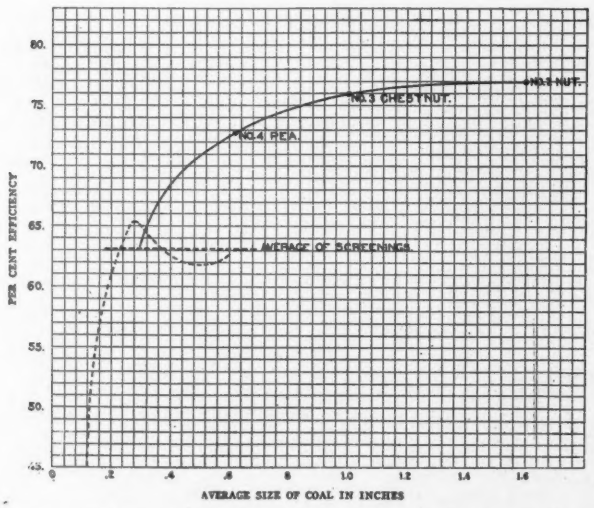


Fig. 1. Efficiency performance of screenings and small prepared sizes of coal

Competition Forced Sizing

Some years later coal production began in Franklin County, adjoining Williamson, in the same No. 6 coal seam. The situation in Franklin County did not favor the development of coal washing, and these small prepared sizes of coal were produced by separation of screenings without any cleaning at all. The result was that eventually, due to competition of Franklin County especially, the coal washers could not compete with the unwashed product, and for some years the washers have been out of business. This would indicate that the value of physical characteristic was the more important factor involved, rather than washing.

As the result of research and experience it has been possible to display the value of the small prepared coal as compared to screenings, as shown by Figs. 1 and 2, from Bulletin No. 56, Illinois State Geological Survey.

Figure 1 displays the performance of screenings having an average value for efficiency of 63 per cent, while that of No. 2 nut reaches 77 per cent and chestnut and pea sizes occupy a position midway between. Figure 2 displays the relation on the basis of capacity. Here capacity for screenings appears at slightly above 41 horsepower.

It is apparent that the small prepared coal has a greater value for capacity than it has for efficiency. Experience corroborates the performance indicated by these diagrams. As an illustration, a process factory located in Elgin, Ill., was equipped with three 72 in. by 18 in. return tubular boilers, served by Murphy furnace stokers. Screenings were the fuel used, with the result that much of the time, with three boilers in service, the factory was subject to serious delay due to low steam. As a remedy it was suggested that No. 2 nut be substituted for the screenings provided for in the coal contract. Chestnut size would have been a more suitable size, but the mine did not produce it. After trial the fuel supply was changed to the No. 2 nut, which came from the same mine that produced the screenings.

The immediate result was that the trouble from low steam disappeared, and one of the three boilers was put in reserve. After a time the capacity of the factory was doubled, and the two boilers took on this additional load. Under these conditions the engineer stated that their only trouble was "to keep the steam down." First, the boiler capacity was cut one-third; then the boiler load was doubled. Later chestnut took the place of No. 2 nut, and for 15 yr. to the present these sizes of nut coal have been used exclusively. Other corroborative performance could be mentioned, but this example may be taken as sufficient, especially as coal cost declined and evaporation per pound of coal increased as a result of the use of the nut coal. Another advantage in this case had to do with coal in storage. It was the policy of the management to carry a reserve stock of fuel. The result was that every summer screenings took fire and there was a serious loss and a disagreeable mess, which was entirely remedied by use of the nut coal.

Porous Fire Bed With Nut Coal

The reason for the superior performance of the nut coal as compared to screenings is due to the fact that it affords a porous open fire bed, so that the air has free access to the burning coal, and at the same time excess air in the fuel bed is avoided.

These nut sizes are at their best when employed as stoker fuel. They are especially adapted to the chain grate, as, due to the uniform size of the pieces, the coal burns off evenly as the fire reaches the end of the grate. For this reason the loss of fuel in the ash refuse is very much less than with screenings.

The fuel loss in the refuse with screenings burned on chain grates varies with different sizes of screenings. Illinois State Geological Survey Bulletin No. 56, at page 82 shows, in an interesting diagram, the range of these losses. With screenings containing 40 per cent of coal of 1½ in. in size, the loss is 6.5 per cent. These losses decline as the percentage of the large pieces is less, until the larger sizes are ¾ in., when this loss is about 2.5 per cent.

The reason for these fuel losses with screenings is that the small coal burns before combustion of the larger pieces is completed, and as the fire arrives at end of the grate these unburned pieces are discharged with the ash. This loss could be avoided by carrying a short fire, which would afford opportunity for the large pieces to burn, but the loss due to excess air from such short fire is greater than that caused by the loss of the pieces of coal. It is therefore apparent that this serious fuel loss with screenings has no remedy.

The disadvantages of screenings are due to the presence of the fine coal that tends to obstruct air supply and the great variety in the sizes of the pieces. The performance of screenings is shown on pages 80 and 81 of the above mentioned Bulletin 56, which contains much other valuable information about coal.

Importances of Fuel Bed Thickness

With chain grate stokers especially, the thickness of fuel bed is most important; it should be in proportion to the size of the coal used. For example, No. 2 Nut requires a very thick bed, while the pea size demands a relatively thinner fuel bed.

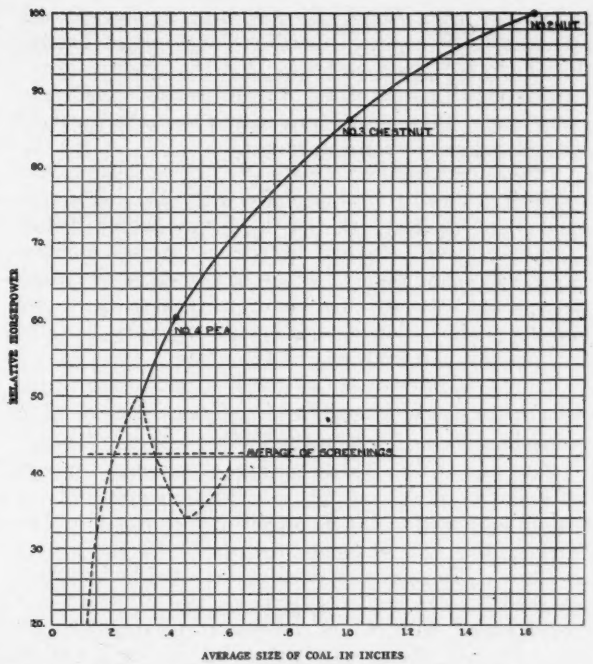


Fig. 2. Capacity performance of screenings and small prepared sizes of coal

The relatively thicker bed of nut coal does not burn away as fast as the thinner bed of screenings, and this may present a problem, as often the stoker cannot be driven slow enough to effect combustion as the fuel arrives at the end of the grate. Thinning the fuel bed, however, is not the remedy, as this results in too thin a fire. The remedy is to provide a sufficient range of speed in the travel of the grate to meet the requirement. The speed adjustment of the stoker is not always sufficient and often requires that change be made in the driving motor, so that it may be operated slow as well as fast enough, so that any required stoker speed may be available.

As capacity is one of the strong points of these sizes of nut coal, it may be, and usually is, necessary to operate with reduced draft to hold capacity down to the load on the boiler.

B.t.u. has quite generally been accepted as a basis of value, but it has limited application in this case, as B.t.u. difference between nut coal and screenings is not very much. It is therefore apparent that value is rather a matter of size characteristic than B.t.u. content.

From the foregoing statement, the question naturally arises as to why so much more coal in the form of screenings than in the nut sizes is used. There are a number of features involved in the answer.

The greater cost of this small prepared coal as compared to screenings is a factor, as many coal buyers are governed by price only.

Mechanical stokers were devised at a time when fine coal was a drug in the market, having little or no value. Therefore, there was an important economy to be had from the use of mechanical stokers, and as this fine coal was the only fuel then available for stokers, there developed a tradition that screenings were the logical fuel.

When small prepared sizes are used on the same

amount of grate surface as had been employed with screenings, the capacity developed is so much greater than had from the screenings, that the tendency is to operate thin or short fires. The consequent inefficient result under these conditions means that the nut coal fails to compete with screenings.

Often, in fact quite generally, the provision for speed of stoker drive, especially with chain grates, is inadequate, especially that of the driving motor. While the stoker itself has speed adjustment, it does not possess range enough and it becomes necessary to reduce the speed of the driving motor, so that a thick fire may be carried under conditions that insure that the fire finish at the back end of the grate.

Thickness of fire bed should be in proportion to the size of the pieces of coal, and the draft should be in proportion to the load on the boiler.

The use of this small prepared coal has especial reference to provision for new boiler equipment. A certain corporation has a number of factories in different localities. These plants are practically duplicates, and as standard practice three stoker-fired boilers were installed for the use of screenings, two of which carried the load, with one in reserve. In designing a new plant for use of the small prepared nut coal, two of the standard size boilers and stokers were provided, and the load carried by one, with the other in reserve. This insured an important saving in cost of plant and in its maintenance.

A very large factory plant required increased steam supply. If screenings were to continue as fuel supply, it involved additional boiler capacity. As the result of an analysis of the proposition it was found that the most economical solution was to change to the nut coal, notwithstanding its higher price. This plant has used chestnut size coal on chain grates for many years.

The main talking point of stoker salesmen is ability to burn "cheap coal," meaning screenings, which, however, has ceased to be the cheap coal that it once was.

Notwithstanding the stoker salesmen's main talking point, the small nut coal is appreciated as far as stoker performance is concerned, but has no part in sales talk. A case in the writer's knowledge concerned the sale of single retort underfeed stokers to burn screenings. After the stokers were in use the salesman approached a coal company with the request that they induce the stoker owners to use nut coal instead of screenings. The salesman's interest in the matter was to insure that this plant would give such desirable result as he had observed in other cases where nut coal was used in his stoker, yet did not feel that he would have secured the order if he had recommended the small prepared coal.

To get the full benefit from these small prepared sizes of nut coal, it is quite generally necessary to change from process usual for screenings. It may be necessary to operate with less boiler capacity.

Slower feed of the stoker increases thickness of fire and restricted draft. The case of the previously mentioned plant at Elgin is one where operating conditions were such that the nut coal fitted into the situation without any change being required other than the dropping of one boiler. Quite generally some engineering management is desirable.

Estimates of Oil Reserves Show No Danger of Shortage

By Victor H. Scales
American Petroleum Institute

ESTIMATES of national oil reserves are largely a matter of guess work as a look at the record will show. In 1889 Dr. David T. Day, then head of the U. S. Geological Survey, warned that the nation's oil reserves shortly would be exhausted. In 1891 the warning was repeated. The first estimate Dr. Day made in 1908 gave a minimum and maximum quantity of oil remaining underground of from 8,015,000,000 to 22,515,000,000 barrels. For error he allowed a latitude of 280 per cent! The second estimate was made by Ralph Arnold, consulting geologist, in 1914. His figure was 5,700,000,000 barrels. In 1915 the U. S. Geological Survey gave 7,600,000,000 barrels as an estimate, plus 75,000,000,000 barrels "prospective" production. In 1918 David White, of the National Research Council estimated reserves at 6,700,000,000 barrels.

In 1925 a committee of experts appointed by the American Petroleum Institute estimated proved reserves at better than 5,000,000,000 barrels, and indicated that 25,000,000,000 additional barrels would be recoverable by then-known methods after flowing and pumping had ceased. In 1926 the Federal Oil Conservation Board stated: "The total present reserves in pumping and flowing wells in the proved sands has been estimated at about 4,500,000,000 barrels, but in 1932 the same authority placed recoverable oil reserves at 10,000,000,000. The Cole Committee, which in 1934 conducted one of the perennial investigations of the industry at the behest of Congress, estimated oil reserves in known fields at 13,360,000,000 barrels.

The latest report by the Executive Committee of the American Petroleum Institute in 1935 takes on added interest in the light of these earlier estimates. Petroleum reserves are more than 100 per cent larger than those estimated 10 yr. ago, it is pointed out. Known petroleum reserves at that time were estimated at 5,321,000,000 barrels, with indications that additional reserves would be found. In the 10 yr. since that calculation, 8,692,000,000 barrels of oil have been produced and consumed—50 per cent more than the entire proved reserves in 1925; yet more than 12,000,000,000 barrels of proven reserves are known to be still below ground, it says. Obviously, it is not extravagant to assume that our national oil reserves are extensive. It is well to remember too that improvements in production methods now make it possible to obtain from 50 to 100 per cent more oil from a given pool than has been possible in the past, and that a consistently larger quantity of refined products of better quality is being obtained from a smaller quantity of crude. Advances made by science, technology, and invention indicate that the reserves still to be located and developed are far greater than have ever before been estimated.

Changing Station Loads

By V. F. ESTCOURT

STAND-BY OPERATION as applied to Pacific coast conditions with combined steam and hydro systems requires the steam plant to operate at or near minimum load, but prepared, at all times, to accept a large percentage of its total capacity as fast as the turbine-governors will respond to sudden reduction in system speed, caused by transmission-line faults, or, complete separation of the steam and hydro systems for any cause.

Although the stand-by problem has been common among steam plants in this territory for many years, its application to large-capacity units operating at steam temperatures above 700 deg. F. and pressure above 400 lb. is a comparatively new development.

Operating in parallel with hydro plants, steam plants on the Pacific Coast are used to irregular operation but the recent depression and draught placed even new 400 and 1400 lb. stations on the standby list and it is not likely that Boulder Dam power will improve conditions.

The author, who is Efficiency Engineer at Station A of the P. G. & E. Co. in San Francisco, presented an unsually complete paper on Design and Operating Problems with Gas and Oil Fired Boilers for Standby Steam-Electric Generating Stations before the Niagara Falls Meeting of the A. S. M. E. Only too often conditions beyond control makes it impossible to operate a station as assumed by the designer and Mr. Estacourt's analysis of the problem and its solution for specific conditions is worthy of close study by all utility engineers.

The portion of the paper presented here deals only with specific tests made and used as data in the solution of the problem. These tests show how fast load may be changed without undue disturbance and also what happens during the first few seconds after full load is suddenly thrown on a machine and the throttle valve opened wide.

What has been accomplished is the result of considerable research and experimentation. The main objective has been to make the practically instantaneous acceptance of large blocks of load a matter of normal operating routine which can be accomplished either semi-automatically or fully automatically from a central control board without undue reliance upon the human factor and with practically the same degree of reliability as can be expected in the case of ordinary load changes.

Investigations were conducted in two different plants, the one designed for a pressure of 1400 lb. per sq. in., with initial and reheat steam temperatures of 750 deg. F., and the other for a pressure of 425 lb. per sq. in. and 750 deg. F. steam temperature, both plants being equipped for burning either natural gas or fuel oil. No measurable difference can be observed in the speed of response to changes in fuel rates or either gas or oil fuel. The limitations with oil fuel are due to the difficulty in maintaining the correct flame angle and proper atomization with standard oil-burning equipment at low loads.

In order to place stand-by operation upon a routine basis, certain procedures must be established to guarantee reliable performance at all times. In the first place, an emergency load pickup schedule must be established on the basis of actual tests. These serve as a guide for the station operators and also for the load dispatcher, and include information as to how much emergency load can be picked up instantaneously from various initial loads, both for the normal set up of boilers and turbines and also for the various conditions where boiler or turbine capacities are curtailed on account of outages of major equipment for annual overhauling or other causes. In Fig. 2 are given typical emergency load pickup schedules for both oil and gas firing for various operating conditions at both the 1400 and 425 lb. plants.

Boiler Water Storage

In the 1400 lb. plant, where the load-pickup schedules given in Fig. 2 apply, no load-limiting device is used to restrict the turbine governor to the loads given in the schedules. The schedules merely indicate the guaranteed minimum that the turbines will handle under the emergency, and include a margin of safety sufficient to allow for unforeseen limitations.

It has been found that, by permitting the governor to open wide whenever speed conditions impose such a demand, the final result is always more favorable to the steam plant than if the control valve stroke were restricted. The initial load can be carried with the steam liberated from boiler-water storage and the result is that, by permitting the turbine to swing to its full capacity initially, there will be a greater recovery in system frequency than would otherwise have been possible, and the net result is usually a lower final load on the turbine after the first few moments. If the boilers have sufficient water storage, such a load may be accepted and held for a few minutes even though there is insufficient boiler capacity to sustain it indefinitely.

In the process of reducing loads to a minimum, another condition is encountered which can be met by means of a schedule for routine load reductions. Due

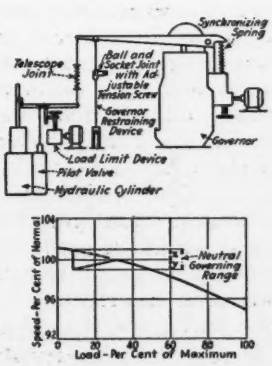


Fig. 1. Governor restraining device used on turbines operating in parallel with hydro plants.

With the large number of hydroelectric plants that form the greater part of most of the generating systems on the Pacific coast, the system speed regulation can be handled most economically at one or more of the hydro plants. Therefore, the governor-restraining device is in common use in the steam plants for establishing a neutral frequency band within which the turbine load is held constant.

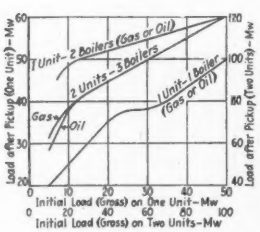
As soon as the speed falls one per cent below normal, the ball-and-socket joint is separated by an additional pull on the governor beam and the turbine is free to pick up whatever load the speed conditions demand. If the speed exceeds one per cent above normal, then the tension on the governor-restraining device is reduced to zero, and a further increase in speed causes the governor to reduce the load on the machine. With the aid of this device, absolutely steady load conditions are maintained for much longer periods of time, with resultant benefits in economy and improved operation without any detrimental effects upon system operating conditions as a whole.

to the large amount of heat stored in the boiler and turbine equipment, it is necessary, during the process of lowering the load on the boiler, to reduce the fuel rate considerably below the requirements for steady load conditions. As minimum load is approached, it becomes necessary to cut out burners until steam-pressure conditions permit the fuel rate to be brought up to the normal steady load rate. Cutting out burners reduces the amount of emergency load that may be accepted on account of the delay due to lighting up burners. If an emergency load demand were to occur during the time some of the burners were cut out of service, difficulty would be encountered in picking up the amount of load specified in the emergency load-pickup schedule. It also disrupts the routine of operation. The schedule for routine load reductions is therefore established so that the load is not reduced any faster than can be accomplished with all burners in service. Such a schedule is given in the table for the 1400 lb. plant. It should be understood that this does not prevent the load from being reduced as fast as desired if operating conditions require it. The schedule establishes a routine which may be easily followed, however, and which contributes a surprising amount to the ease of handling load reductions.

Superheat and reheat temperatures increased from 725 F. to approximately 775 F. for a few minutes and then returned to about 750 F. It was found that the increase in drum water level was only slightly more than that which is characteristic of the setting of the three-element water-level control, which is adjusted to give approximately 3½ in. rise in level from minimum to maximum boiler load. The time required to increase the rate of fuel and air flow from minimum to maximum was approximately 24 sec.

During the first few seconds, the high-pressure generator was slightly overloaded and the differential pressure between the third admission and the ninth stage exceeded the maximum allowable value by approximately 2½ per cent. Both of these conditions were of momentary duration and were not detected by observers during the test, although visible in the motion pictures. There was no evidence of instability of the high-pressure generator in relation to the low-pressure generator.

The stage pressure curves in Fig. 4 shows a definite time interval for the steam pressures to build up to their respective maximums in the various stages. An appreciable amount of energy is absorbed in building up the turbine and extraction-heater system to the new


1 Unit–2 Boilers (Gas or Oil)
2 Units–3 Boilers
1 Unit–1 Boiler (Gas or Oil)
Gas
Oil
Load after Pickup (One Unit)–Mw
Load after Pickup (Two Units)–Mw
Initial Load (Gross) on One Unit–Mw
Initial Load (Gross) on Two Units–Mw

General. All load-pickup schedules are based on having the full number of burners in use at all times; this also permits normal operation of the combustion-control system. In order to maintain these conditions while the load on the units is being reduced, it is necessary to allow time for the stored heat in the boiler and turbine equipment to be dissipated before dropping to minimum load. The amount of heat thus stored varies with the load. The following schedule should be considered as the maximum rate of dropping load except when unusual conditions require a faster rate.

Schedule from Full Load: (1) Drop to 25,000 kw. in steps of 5000 kw. every 2 min. (2) Wait 10 min., then drop to 15,000 kw. in steps of 5000 kw. every 2 min. (3) Wait 10 min., then drop to 10,000 kw. (4) Wait 10 min., then drop to 5000 kw. Total time required to drop from full load to 5000 kw. on this schedule is 46 min.

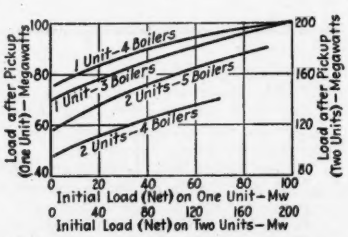

1 Unit–4 Boilers
1 Unit–3 Boilers
2 Units–5 Boilers
2 Units–4 Boilers
Load after Pickup (One Unit)–Megawatts
Load after Pickup (Two Units)–Megawatts
Initial Load (Net) on One Unit–Mw
Initial Load (Net) on Two Units–Mw

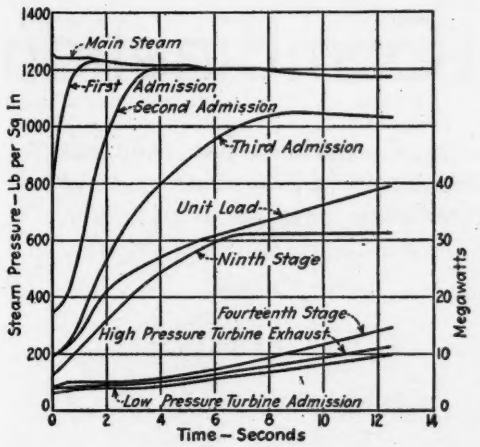
Fig. 2. Emergency load-pickup schedules for a 122,000 kw., 1400 lb. plant (left) and 200,000 kw., 425 lb. plant (right) showing how much emergency load may be picked up instantaneously under different conditions of operation. (Center) Schedule of routine load reductions on the 1400 lb. plant turbo-generators

Actual load-pickup tests with gas fuel were first conducted at the 1400 lb. plant on one of the 61,000-kw. compound units. At the time of the test, both turbo-generators were in operation and receiving steam from the one standard and two reheat boilers, but the load pickup was handled by one reheat and one standard boiler. The load on the other reheat boiler and turbine were held constant, although the benefit of the steam-storage capacity from all three boilers was obtained. This showed up clearly on the boiler flow-meter chart for the reheat boiler which was being held at constant load, a momentary increment in flow from 75,000 to 235,000 lb. per hr. being recorded, although there was no change in the rate of fuel input. This, however, dropped back to normal very quickly.

The restraining device, Fig. 1, was used to block the turbine governor at a steady load of 10,000 kw. The governor-synchronizing spring was then run out to the full-load position, and at a prearranged signal the ball-and-socket connection at A was broken, permitting the governor to open the turbine control valves to their wide-open position in 3 or 4 sec. A motion-picture record was made of throttle steam pressure, stage pressures and generator load. These are given in Fig. 3 for the first 12 sec. of the test, together with the drum and throttle pressures, fuel-input rates and generator loads for the period of the test.

Load-pickup tests with gas fuel were also conducted on one of the 110,000-kw. units at the 425 lb. plant. Some interesting studies were made of the results that could be obtained under several different operating setups. All tests were made from an initial load of approximately 1500 kw. gross. Load was applied by instantaneously raising the pilot-valve lever on the turbine-governing mechanism. Although the operators knew at what time the tests were to be made, no changes in the normal stand-by setup were made except for the use of the high-speed operation of the control drives.

Results of the four principal tests are given in Fig. 4. Curve 1 shows the performance with three boilers as stand-by capacity. With this arrangement 80,000 kw. can be carried on the main generator and station auxiliaries supplied by the house set. However, as the steam pressure drops so low and complete recovery is delayed for 15 min., it can be concluded that this setup leaves no margin for safety. If there should be any delay in getting fuel to the boilers or if a fan should fail to start, the performance under emergency stand-by would be greatly jeopardized. To supply reliable stand-by service, more boiler capacity than that provided by three boilers is needed. Use of this setup also allows the steam temperature to reach a very high level before



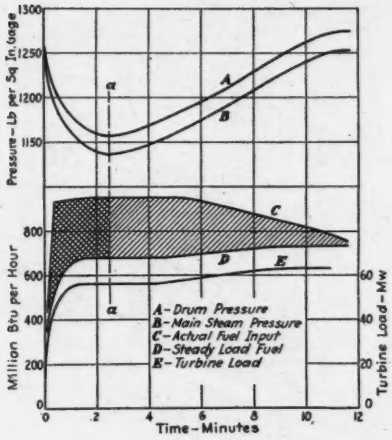

Pressure – Lb per Sq In. Gage
Million Btu per Hour
Turbine Load – Mw
A – Drum Pressure
B – Main Steam Pressure
C – Actual Fuel Input
D – Steady Load Fuel
E – Turbine Load
Time – Minutes

Fig. 3. Pressure and load conditions during the first portion of a load pickup test on a 1400 lb. plant

steam pressure is fully restored after about 15 min.

Curve 2 shows the same test conditions as Curve 1, but with four boilers sharing the load. Time for complete recovery is diminished from 15 to 4 min. and at the same time a greater load is carried. The drop in pressure shown on the curve after 4 min. was due to the firemen cutting back on the fires prematurely.

Curves 1 and 2 were obtained with the main generator load limited to 90,000 kw. and with the house set supplying the station auxiliaries. Curve 3 shows the results of a test made with 4 boilers supplying steam and the turbine admission valves wide open throughout the test with the house set off. Higher load is carried throughout the test period because of the more efficient use of the steam available during the first few minutes. This is due to the generation of the auxiliary power requirements with the main turbine instead of with the house set.

Calculations reveal that considerable heat left the turbine during the first 2 min. to heat the feedwater in the heaters and piping. It was reasoned that, if this heating could be delayed for a few minutes, the same heat could be used for generating power and the feedwater could be heated later after more steam was available from the boilers. Therefore, in an attempt to obtain greater load during the initial phase of the pickup period the extraction valves were throttled until the gates were within ¾ in. of the bottom of the seats. Results of such a scheme are shown on curve 4, Fig. 4. It can be seen that more load is picked up during the first half minute but that it is soon lost and is not readily increased afterward and lags behind Curve 3.

Since such operation is virtually nonextraction, the excess steam is not readily condensed and the result is a reduction in the vacuum with a consequent loss of load. The excessive rise of back pressure is clearly shown by the curves in Fig. 4. This might be reduced with the use of two circulators instead of the usual one during an emergency pickup.

At the minimum load the boilers are operated with natural draft. Determination of the minimum time required to bring the fans to maximum speed from minimum stand-by position gave an average of 24 sec. This is the time from the closing of the fan switch and pressing the "more" button until the drive has reached the 100 per cent position. Under test conditions, the time required to reach maximum fan speed and maximum fuel flow varied from 34 sec. to 1 min. after the turbine valves were opened.

When full fuel flow is established in 1 min. or less, the effect of opening the feedwater valves, causing an increased flow of water into the boiler and thereby lowering the steam pressure somewhat, is minimized. If the boiler commences to take water at the time of minimum pressure, the restoration of pressure is retarded. For this reason it is well to keep the water level at about 5 in. on the gage when on stand-by so that the addition of water will not be required immediately. On these tests it was found that the water in the boiler would "swell" from an initial level of 5 in. to about 15 in. The swell is only momentary as the increase flow of steam soon lowers the water level.

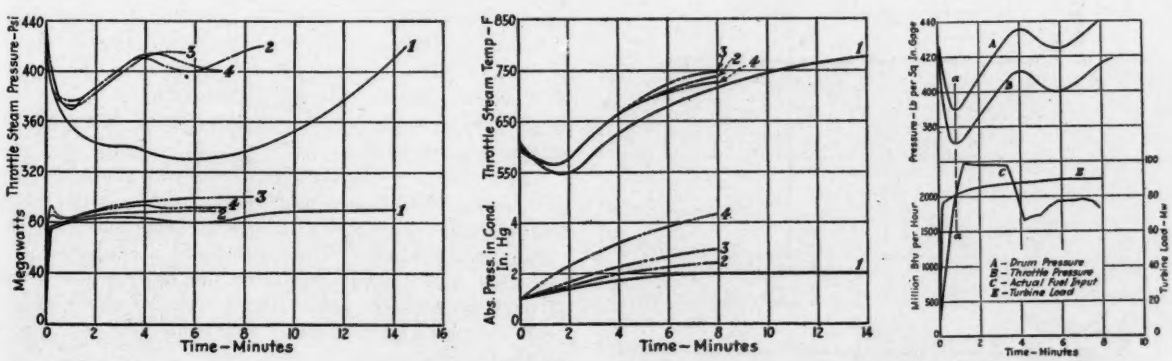

Throttle Steam Pressure – Psi
Megawatts
Time – Minutes
Throttle Steam Temp – F
Abs. Press. in Cond. In. Hg
Time – Minutes
Pressure – Lb per Sq In. Gage
Million Btu per Hour
Turbine Load – Mw
A – Drum Pressure
B – Throttle Pressure
C – Actual Fuel Input
E – Turbine Load
Time – Minutes

Fig. 4. Steam, condenser and load conditions during load pick up tests on a 425 lb. plant

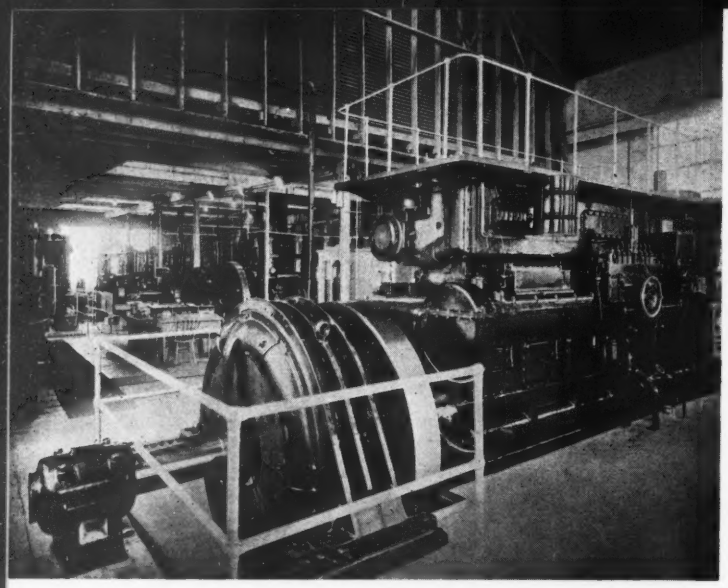


Fig. 1. Interior of the Carlsbad Diesel station

Combination

Years of experience has standardized operating procedure and cut attendance cost to a minimum. Engines maintain system frequency and voltage

By E. A. ROBERTS

Southwestern Public Service Co.

Carlsbad, N. Mex.

POWER for the local utility system of the Southwestern Public Service Co. at Carlsbad, N. Mex., is supplied by an interesting combination of hydro and Diesel plants. The first were built years ago before Diesel power was available, and, in a country where coal has never been sold for much less than $15.00 per ton, thus ruling out steam power in small units. At one time the hydro plants furnished all the power for the town but that time has long passed. The old generating equipment has been replaced and brought up to date but the dams and water-ways are nearly in their original condition.

Two hydro plants are located on the Pecos River, one in the city limits and the other 7 mi. downstream and southeast of the city, as shown by Fig. 2. The plant in town has two Electric Machinery Co. 225 r.p.m., 2400 v. alternators direct connected to S. Morgan Smith water turbines, one is an 85-kv-a. unit driven by a 93-hp. wheel and the other a 112-kv-a. unit driven by a 130-hp. wheel. The lower river plant, called the South Plant, has one 312-kv-a., 2400 v., 180 r.p.m. Westinghouse generator connected to a 300-hp. Worthington turbine and one 100-kv-a., 225 r.p.m. Westinghouse generator connected to a 120-hp. Worthington turbine. Exciters are belt driven through quarter turn belts. The turbines at the south plant operate under 17 ft. head and the ones at the north plant under 13 ft. All hydro generators are of the vertical type and carry the turbine loads from thrust bearings in a bracket on top of the machines.

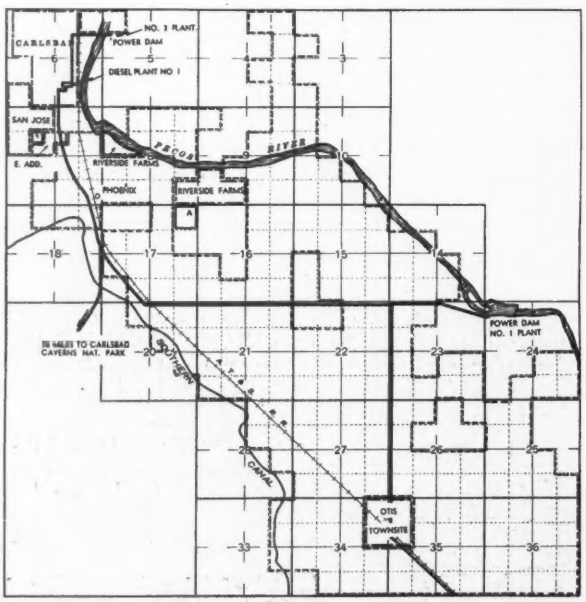


Fig. 2. Map showing the location of the two hydro plants and one Diesel plant with connecting transmission lines

Both hydro plants are operated as nearly as possible in accordance with the river flow, that is, the gates are opened to pass the quantity of water coming into the lake so as to keep the head constant. The south plant is usually run at full capacity over the peak for a couple of hours each day. For the past several years the river flow has been below normal and each year has seen a decreasing output from these plants.

During 6 mo. of the year the hydro plants generate nearly 40 per cent of the total system output but, as their peak is only 360 kw. under favorable conditions, there is never a time, except light load periods on Sundays, when they might operate alone. Their regulation under changing load and their low WR^2 rating makes satisfactory service impossible however so an engine is always run in parallel with them to regulate speed and to maintain frequency and voltage. Power factor conditions also make this advisable.

At the north plant, there is no operator and the gates are set for the load that the river flow will carry and the plant is locked up. No trouble has been experienced so far with this method of operation and except for a daily check up no one is around the plant for days at a time. In case trouble on the system makes a change that requires necessary a man goes over and sets the gates, puts the machines back on the line if they have tripped off, or, shuts them down as the emergency requires.

Two men are employed at the south plant, but for one shift of 10 hr. the plant is shut down entirely, or, run with the wheels set at a predetermined load and no one in attendance. The south plant is equipped with governor and voltage regulator but it operates better in parallel with the other plants without using either, both voltage and frequency being controlled entirely by the engine plant.

The north plant feeds into the bus at the engine

Diesel and Hydro Systems

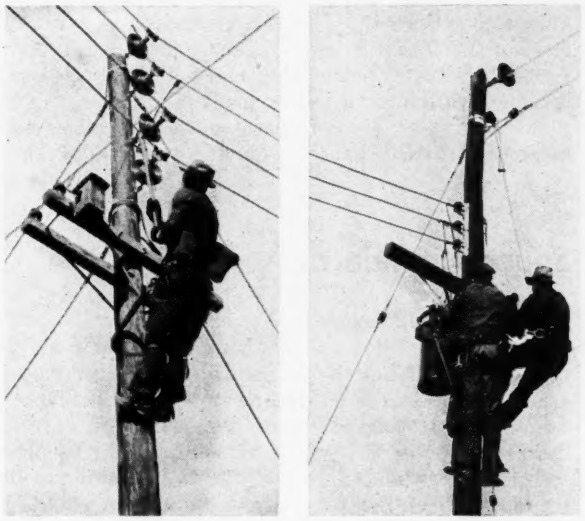


Fig. 3. Left, a corner of the 11,430 v. line and, right, rural construction showing at the top the single phase line mentioned in the text

plant at 2400 v., while the south plant voltage is stepped up by three 100-kv-a., 2300/6900 v. transformers, connected delta on the low side and Y on the high side with the neutral grounded to give 11,430 v. between phases. The line is built with four wires and feeds back to the engine plant where there are three 200-kv-a. transformers connected in the same way, Y to delta. A tap takes off this line for service to the towns of Loving and Malaga and the surrounding farming country.

Service is taken from this line either with 11,000/2300 v. transformers connected between phases or from 6900/2300 or 6900/110/220 v. transformers connected from a phase wire to the neutral wire. The neutral wire is grounded at every transformer and at many other places where good ground conditions exist. Single phase lines are built with one "hot" wire on a fixture on top of the pole and a ground wire on a bracket below it, no cross arms being used. All uew transformers for this service are bought in the rural type with one bushing and built-in protection. This construction has proved economical and satisfactory. The grounded neutral wire has proved a great help in controlling lightning troubles.

Diesel Plant

The Diesel plant, located in town, has five units, all Fairbanks-Morse 257 r.p.m. engines driving 2400 v., 3 ph., 60 cycle generators. These units are rated as follows: one 150, one 200, two 360 and one 840 hp. The 840 and one 360 hp. engine have recently been rebuilt with new open type heads and differential injection nozzles and the change has improved both service and economy. The net output for the plant, all engines counted in and all current used for pump motors, mg. sets, lighting, etc., deducted averages over 11 kw-hr. per gal, of oil used.

Fig. 4. Exterior of the Diesel station

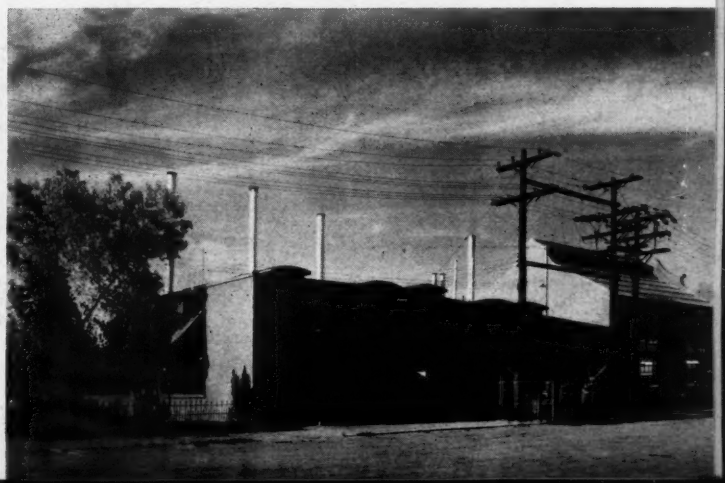
Generators are excited from separate 14 and a 25-kw. motor generator sets with 2300 v. motors. These sets are run in parallel when necessary. Voltage is controlled by General Electric voltage regulator. Two engine units have belted exciters which can be used when desired, or, when necessary to get started in case of total absence of power. This is a rare occurrance, however, as one or the other of the hydro plants is able to furnish current even in extreme cases of trouble due to storms or accidents.

Compressed air is used for starting and is stored at two pressures in tanks outside the building. Two hundred and fifty pounds pressure is used on the newer engines and 180 lb. for the 150 and the 200-hp. units. The same compressors are used for air service, relief valves on the low pressure tanks opening if the wrong valve should be opened.

A Marley cooling unit is used with soft water in a closed system. Raw water is pumped through spray nozzles over copper coils consisting of 3800 ft. of ¾ in. copper pipe, 5-hp. motors drive centrifugal pumps, rated at 450 g.p.m. each at 34 ft. head, which handle the raw cooling water. Water in the closed system is circulated through the engine jackets and the cooling system by three 4 in. centrifugal pumps, one driven by a 5-hp. and two by 10-hp. motors. All these pumps were used previously to circulate cooling water over an open cooling tower. Since installing the closed system in November, it has been found that the 5-hp. pump is usually sufficient to do the work while the others remain idle. In cold weather little raw water is sprayed on the coils and at night with light load, none, as the air gives sufficient cooling. Water consumption has dropped from 500,000 gal. per mo. with the open tower to 50,000 gal. per mo. for the closed system. A zeolite water softener is used to soften water and scale trouble has been eliminated.

Filters and Oil

Air filters are installed on the 840 and on both 360-hp. engines. Lubricating oil is centrifuged continuously for the 840-hp. engine and a centrifuge is installed for fuel oil but is not needed with the fuel now being used. Fuel oil is shipped in tank cars from a Texas point and unloaded through a pipe line into



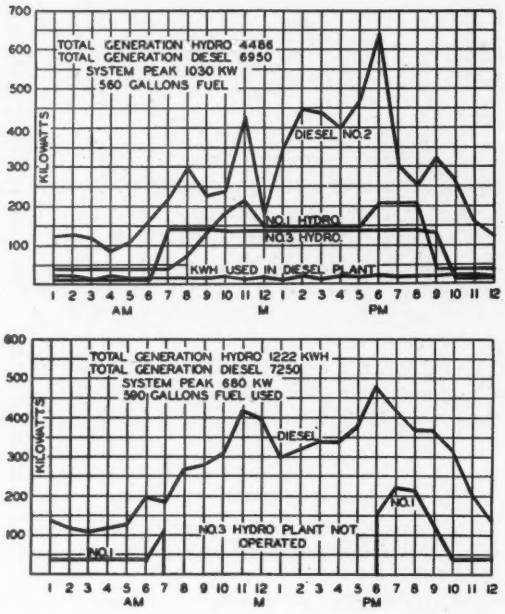


Fig. 5. Typical load curves showing division of load. Top, November 17, 1936; bottom, February 11, 1937

storage tanks at the plant. Two cars of fuel are kept in storage at all times.

Fuel oil of 30 to 34 A.P.I. is used. Heavier oil can be burned but experience has shown that the lighter fuel burns better and gives a lower total cost. The new type injection nozzles are prone to clog up with heavy oil and dirt in the oil is sure to cause trouble. The lubricating oil centrifuge is a Sharples. The electric heating element has been discarded and the oil heated by steam in a coil, the steam being taken from a water jacket on the exhaust pipe of the 840-hp. engine. The fuel oil centrifuge is a Goulds. The cold fuel oil is brought in through a pipe run inside of the discharge pipe carrying off the heated oil from the centrifuge so that part of the heat is saved and the fuel enters the heater partly heated.

In addition to the two men operating the hydro plant a crew of five men consisting of a chief and four operators handle the Diesel plant. This crew does all maintenance work at all plants and little extra help is required.

Absolutely no trouble has been experienced in running in parallel with any combination of the nine small units making up the system, or, in running all nine units at one time. The load can be divided in any way, making any machine take and carry any load desired. Probably more synchronizing and switching of units is done each day than in any plant in the country and it is rare indeed for an operator to be careless and cause enough disturbance to show on the voltage chart.

Fig. 6. This jacket on the engine exhaust supplies steam for heating the oil before it enters the centrifuge and has eliminated use of the electric heater. The Zolite water softener on the left together with a closed cooling water system has entirely eliminated trouble due to scale

Sound Standards

A STANDARD acoustical terminology for "sound" engineers which will eliminate confusion in movie, radio, and building fields has just been completed, according to an announcement of the American Standards Association today. This standard, 4 yr. in development, is the work of engineers, musicians, manufacturers, and scientists working together under the auspices of the American Standards Association, the national clearing house for standardization in the United States.

The committee gives a broader meaning to the word "noise," now defined in terms of the listener as an "unwanted" sound, rather than in terms of the sound itself. Thus the notes of a soprano in the next studio may under certain circumstances be rightly described as "noise." Another section of the standard deals with architectural acoustics. Another which provides standard terms for the measurement of hearing, will be used widely by the medical profession and by manufacturers of aids for the partially deaf. Other parts dealing with the conversion of sound to electrical energy, and with acoustic transmission systems, will be of particular value to the movie and radio professions.

A separate section for music brings engineers and acoustical experts into agreement with musicians on a basic standard pitch, the importance of which can be judged by the fact than an increase of only 4.14 per cent in pitch carried out through the entire keyboard of a piano would throw an additional strain of something like half a ton on the framework of the instrument. Singers, also, are interested in knowing that the pitch of the orchestra they sing by tonight will be identical with the piano in their practice studio.

Accredited representatives of many groups including radio, motion picture, building, manufacturing, electrical, medical, municipal, and Departments of the Federal Government, contributed to the development of this standard. The Association has already approved two other standards in the "sound" field. One of these, completed eight months ago, establishes "reference" and "intensity" levels for sound measurement. The other specifies the characteristics of "noise meters" used by builders, radio engineers, and music teachers. Before this second standard became available no two meters on the market could be depended upon to register similar or even comparable results for the same sound.

Longer Life For Diesel Valves

Are you hardfacing your valves and seats? If you are not you are missing a good bet. Here are detailed directions for doing it right down to the final lapping-in.

By R. K. Kennedy,
Haynes-Stellite Co.

Fig. 1. Hardfaced exhaust valve seats on this battery of four 250 hp. gas engines increased the time between grinds from 6 to 12 weeks to 12-16 months

MANY RUNS have been made within the last few years to determine the suitability of various materials for Diesel exhaust valves and valve seats. Ordinary steel valves seating on a cast iron seat machined in the block or head have not proved entirely suitable over extended periods of operation, and a number of alternatives have been tried to improve valve performance. Inserted valve seats of alloy steel were a natural carry-over from the automotive industry, but they, too, have been improved upon.

A thorough test of seating materials was recently made by a shipping concern which operates Diesel powered vessels on the Great Lakes and Atlantic Seaboard. One of the ships, powered by a 900-hp., low-speed Diesel engine, had suffered valve trouble to such an extent that it had to be laid up every month while the twelve 5-in. Diesel exhaust valves and valve seats were reground.

In an attempt to find a more suitable material for the valve seating surfaces, valves and valve seats of several different metals were tested. These valves and valve seats were put in service, and accurate records of maintenance requirements of each valve and valve seat material were kept. Table I shows the results obtained from this check-up over one season.

From these results, it was obvious that the valves hardfaced with Haynes Stellite, an alloy of cobalt, chromium and tungsten, required less maintenance than any of the other materials under test. In addition, it was found that 7 mo. was actually a conservative figure for the total life of the hard-faced valve, since the tabulated figures were based on the fact that 7 mo. after the hardfaced valves were installed, the ship was dry docked for a complete motor overhauling, during which refinishing the valves was but a precautionary and incidental part of the work.

These results, which are typical of those being obtained in a number of Diesel installations, effectively prove the value of hard-faced valves and valve seats. The method of applying Haynes Stellite to the valves and valve seat inserts follows the same general lines that are employed in hardfacing automotive and aircraft engine valves and valve seats, the only difference originating in the larger size of Diesel power plant valves. In applying the alloy to the valve seat, it is never recommended that it be welded directly to the cast iron of the block or head; rather, it should be applied to a machined steel insert, which in turn is set in the cast iron by screwing, locking, shrinking or other method which insures a tight fit, conducive to a good heat transfer. The most essential feature in hardfacing internal combustion engine valve seating surfaces is to obtain a good deposit, absolutely free from flaws. This can easily be accomplished if a few precautions are observed.

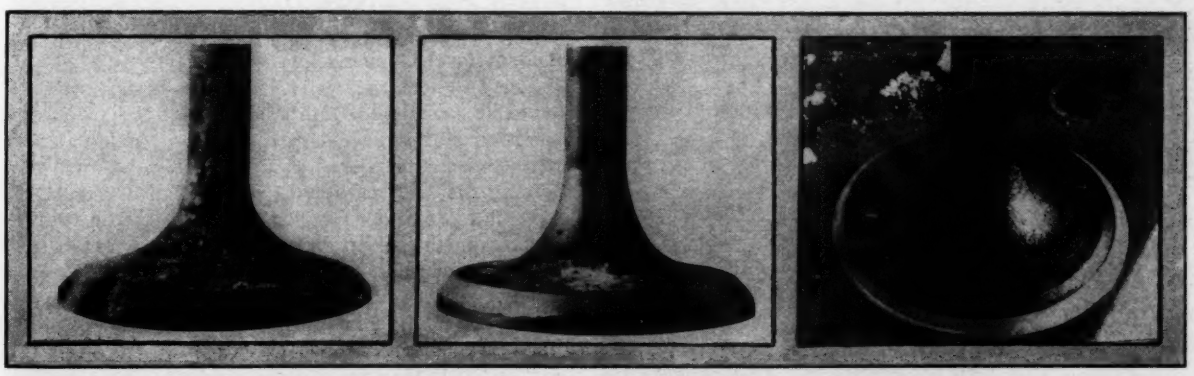


Fig. 2. A 5-in. steel Diesel valve after 1 mo. service. Notice the condition on the left side

Fig. 3. A 5-in. hardfaced valve after 1 mo. service. Compare the condition shown by Fig. 2

Fig. 4. A hardfaced valve after 7 mo. service ready to be lapped into the seat and continue its run

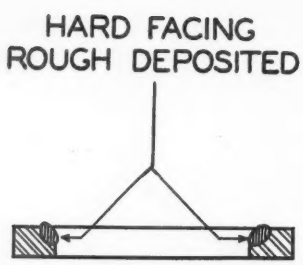


Fig. 5. Rough deposit of hardfacing properly applied to a valve seat

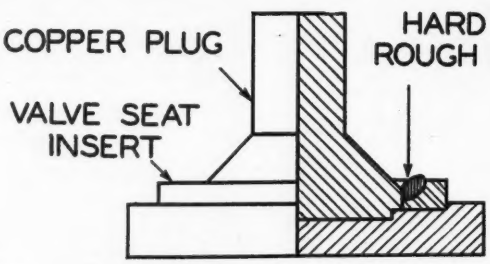


Fig. 6. Application to the seat is facilitated by the copper plug

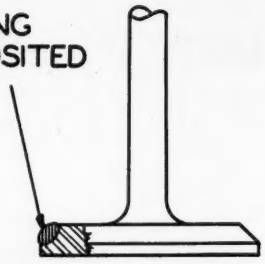


Fig. 7. Application to a valve. Notice the prepared concave surface in Fig. 8.

Before applying Haynes Stellite to valve seat inserts, the steel ring should first be machined, allowing about 1/16 in. of steel on the outside diameter to allow for shrinkage or any slight warping which may occur during the welding operation. The hole in the seat, that is, the inside diameter, should be bored out to 1/32 in. less than the finished size to allow for distortion. This excess stock can be removed after the seating surface is hard-faced. In machining the seating surface, allowance, of course, must be made for the alloy deposit. This allowance should not be less than 3/64 to 1/16 in. in thickness. In addition, the beveled seating surface should be made slightly concave to provide adequate support for the deposit.

Table I. Results of a season's test runs on different types of valves and seats

Valves	Time Before Servicing Required	Type of Service Required
Steel (cast iron seat)	1 month	Grind
Haynes Stellited (bronze seat)	2 months	Light grind
Haynes Stellited (Haynes Stellited seat)	7 months	Lapped into seat
Valve Seats		
Cast Iron (steel valve)	1 month	Grind
Bronze-Surfaced (Haynes Stellited valve)	2 months	Grind
Haynes Stellited (Haynes Stellited valve)	7 months	Lap with valve

The valve insert should be preheated in a furnace or with the welding flame before actual hard-facing takes place. The hard-facing operation, which is carried out with an excess acetylene oxy-acetylene flame, consists essentially in heating the base metal to a sweating heat and flowing the alloy onto the steel surface. The operation should be carried through to completion without interruption. In joining the weld, the deposit should be thoroughly fused and the flame removed very gradually to eliminate too rapid shrinkage and the possibility of pin holes or a coarse grain structure after grinding.

In some cases when applying the alloy to the seating surfaces of valve seat inserts, a copper plug is used inside the insert to prevent the deposit from running over the edge and into the hole. This is shown in Fig. 6. It may be of value to the welding operator to use a copper plug until he has gained enough experience to do without it, even though it does slow up the welding operation considerably. Figure 5 shows a cross section of this deposit when made without the use of the plug. Usually valve seat inserts require no heat-treatment after the hard-facing operation. Only a slow and even cooling is necessary. This can be done either by cooling the insert in a furnace or by placing it in lime, mica, or other loose insulating material while cooling.

Valves

In preparing the valve for hard-facing, the seating surface should first be machined sufficiently undersized to allow for a deposit thickness, when finish-ground, of not less than 3/64 to 1/16 in. The beveled seating surface of the valve, like that of the insert, should be machined concave to provide proper support for the deposit. It is also advantageous to allow 1/16. in. of stock on the outside diameter of the valve head, in order to be sure that the edge will be satisfactory after grinding.

The valve should be preheated either in a furnace, or with the welding flame before actual hard-facing takes place. A furnace is preferable because of the thoroughness and evenness with which the heat can be applied. When it is at a dull red heat, the valve should be placed on a copper, carbon or graphite disk slightly larger than the valve head, preferably one which can be rotated by suitable means. The hard-facing alloy should then be deposited in the same manner as recommended for the valve seat inserts.

Due to the larger mass of metal in the valve, it should be cooled slowly in a furnace after hard-facing. This is absolutely necessary to insure a flawless deposit on the seating surface. A cross-section of the valve showing the alloy as deposited is shown in Fig. 7.

Both valve and valve seat inserts must be brought down to finish size by grinding. Grinding can best be done on a grinding machine. The wheel speed should be between 3,000 and 4,500 surface ft. per min. for best results. A medium soft wheel of a grade between 46 and 60 is recommended. Higher speeds, or wheels that are too hard, are apt to cause grinding checks due to

Fig. 8. Refacing a 40-lb. Diesel engine valve. Notice how the valve has been ground concave so as to give adequate support to the deposit

Table II. Recommended wheels for grinding valves and seats hard-surfaced with Haynes-Stellite

Manufacturer	Valve Seat Inserts		Valves	
	Small	Large	Small	Large
Abrasive Co.	W607-VPJ-SH SB Borolon Vit.	W542-VPJ-SH SB Borolon Vit.	607-VGM-A Borolon Vit.	462-VGM-E Borolon Vit.
Bay State Abrasive Co.	7280-1 J-5-AAA	7246-1 J-5-AAA or 7360 K-5-AAA	7246 M-5-AA	7246 L-5-AA
Carborundum Company	60-M-278	50-M-278	401-M-28	401-M-28
Detroit-Star Grinding Wheel Co.	55/60-K	44/60-L	46-M42	46-M42
Macklin Co.	2946-K Alum 402	2946-J Alum 402	2950-M Alum 402	2950-L Alum 402
National Grinding Wheel Co.	BS22-60A	BS22-50	W29-60	W28-50
Norton Co.	3860-K	1960-L	46-N5B	46-N5B
Precision Grinding Wheel Co.	F-6030-L Hy-Tens Vit.	F-4623-H or I Hy-Tens Vit.	F-60 to 100 J or K Hy-Tens Vit.	F-60 J or K Hy-Tens Vit.
Safety Grinding Wheel Co.	#99 Rex 24-M	Litan-36-A 3/4	Litan 60-P	Litan 46-P
Sterling Grinding Wheel Co.	WW46-J Vit. WWSTH	WW46-I Vit. WWSTH	WW60-L Vit. WWSTH	WW60-L Vit. WWSTH

overheating. Table II will serve as a guide in selecting grade and grain, but other brands of wheels may, of course, be used.

When Diesel valves and seats are hard-faced and finished in this manner, the deposit of hard-facing material should be sound, undiluted by the iron of the base metal, and free from surface imperfections. The support given to the hard alloy by the concave contour of the base material insures that the alloy will not crack or chip and the bond between the alloy and base metal is as strong as, if not stronger than, the alloy itself.

Long Service

Even when only the valve seat insert has been hard-faced, and the valve has not, good results have been obtained under heavy duty service. A record of service with hard-faced valve and valve seat inserts kept by one of the large gasoline plants in Oklahoma is ample proof of this. At this plant, steel valves, together with alloy steel exhaust valve seats, lasted from 6 wk. to 3 mo. After the installation of Haynes Stellited valve seat inserts, the valves required grinding only after from 12 to 16 mo.

Best results are, of course, obtained when both the valves and valve seat inserts are hard-faced. The smooth alloy deposit on the valve seating on a similar deposit on the seat possesses an extremely low coefficient of friction, and, because both surfaces are extremely hard and wear-resistant at elevated temperatures, little tappet adjustment is necessary. When two surfaces of this alloy are working together, an extremely high polish is obtained which is very resistant to wire-drawing or pitting from scale or incandescent carbon particles.

For Steam Valves

It is not unusual that hard-faced valve seating surfaces have been found most suitable for Diesel valves and seats. Over 5 yr. ago hard-faced valve seat inserts were first employed in heavy-duty engines, and they have now become standard in the majority of trucks and buses. Valve manufacturers are now prepared to supply hard-faced valves and inserts, ready for installation, for practically all makes of heavy-duty engines. In the same way, hard-faced valves are now employed extensively for handling high-temperature, high-pressure steam. These services all involve essentially the same conditions, erosion, corrosion, and severe heat, and it is reasonable to assume that an alloy which can economically withstand one type of service can also serve well in the others.

Diesels Carry On

AGAIN in the Louisville flood the small Diesel generating set proved its value, one company alone, the Caterpillar, rushing the five available units from its factory at Peoria to the flood district by truck to augment the limited supply already there.

Tube-Turns, Inc., put two of the 60 kw. sets into emergency service and have since made the installation permanent.

Brown & Williamson Tobacco Co., utilized a 44 hp., belted unit and a 20 kw. generating set which was later rushed over to the Police Department short wave station.

One of the 20 kw. sets went into the Standard Printing Co. plant running presses turning out special Red Cross bulletins. A 40 kw. set pulled 150 hp. in motors to save many thousand copies of partially completed current magazines for the C. G. Dearing Printing Co. Another unit in the Standard Gravure plant shut down and was replaced by a similar engine from a show room tractor.

The accompanying photograph shows an emergency installation for the John P. Morton Co. Rheostat and controls were tacked to a parking box, an oil drum served as a fuel supply and the exhaust line was simply twisted around until a convenient opening was found in the roof.

Although heavily overloaded the engines stood the gaff while the emergency lasted, and repair costs will be negligible compared to the valve of the extra work turned out. Nor was the service unappreciated, as eight more Diesel-electric sets and five more engines of this one make have been ordered for service in the Louisville area.

An emergency Diesel installation in the flood area

ELECTRON TUBES— Principles and

PART XV

By A. W. KRAMER

THE phototube, popularly known as the Electric Eye, is one of the marvels of the present age. Sensitive, inconceivably rapid in its action, it has made possible many new instruments and devices which are finding their way into industry at an increasingly rapid rate. The fundamental action of the phototube is explained in this article.

THE TUBES which we have considered so far can all be classified as serving one or more of three general purposes; they can be used as rectifiers, as amplifiers (or relays) or as oscillators, that is, as generators of alternating currents or electrical oscillations of any frequency. In the latter role they serve, fundamentally, as converters of direct current into alternating current.

All of the tubes considered, furthermore, are of the thermionic type, that is, the electrons are produced thermally by heating the cathode to a high temperature. As will be shown later there are other types of tubes also useful as rectifiers and as relays which do not depend upon a hot cathode for supply of free electrons; these are known as cold-cathode tubes and form a separate classification. Before these are described, however, we will consider another type of tube which is very useful in industrial applications and which usually operates in conjunction with the types of tubes already considered. This is the phototube or the photoelectric tube as it is generally called.

The phototube, as its name implies, depends for its operation on the action of light or radiant energy. In the public mind, it is one of the wonders of the present age and popularly it has become known as the "electric eye," but this term is inaccurate because the phototube does not "see" in the same sense that the eye does. It is simply a device which controls an electric current by the action of light. It is marvelously sensitive, however, and can be used as readily to measure the intensity and the quality of light from a distant star as it can measure the amount of smoke going up the stack of a steam power plant. In many applications it is used merely as a relay—to open or close an electric circuit by the incidence or interruption of a beam of light; in others it is used to modulate an electric current in exact accordance with minute variations in light intensity. Again, in other instruments, it is used to analyze colors. Its speed of action is almost inconceivable and it can follow variations in light intensity of millions of cycles per second without the slightest difficulty. It is the device that makes television possible.

Notwithstanding its amazing capabilities, the operation of the phototube is no more difficult to understand than that of the simplest thermionic tube, the diode. The only difference is in the way the electrons are emitted from the cathode, but in that we encounter one of the strangest things in modern physics. For here we encounter a very fundamental interaction between light and matter, a phenomenon which has occupied some of the keenest minds of science for over half a century and which has led to startling changes in our whole understanding of nature. These matters need not concern us here, however, but we shall discuss them later. At present we will concern ourselves only with the simple principles of the phototube's operation.

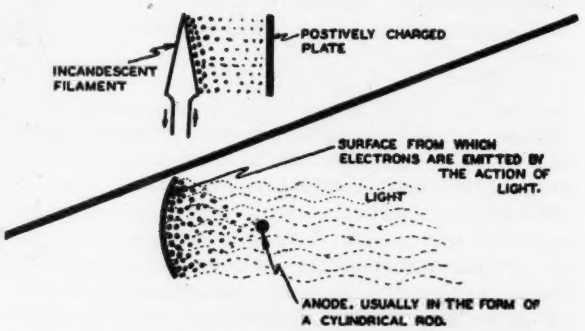

POSTIVELY CHARGED PLATE
INCANDESCENT FILAMENT
SURFACE FROM WHICH ELECTRONS ARE EMITTED BY THE ACTION OF LIGHT.
LIGHT
ANODE. USUALLY IN THE FORM OF A CYLINDRICAL ROD.

Fig. 1. Diagrams showing the difference between the thermionic diode and the phototube. The thermionic tube is shown above; here the electrons are "evaporated" out of the cathode by heat. In the phototube, shown below, the electrons are emitted from the cathode surface by the action of light

As stated, the only difference between the thermionic diode and the phototube is in the way electrons are emitted from the cathode. In the thermionic tube, the electrons are emitted by the action of heat—by heating the cathode to a relatively high temperature so that the electrons are virtually "boiled" out of the metal in much the same way that molecules of water are boiled out of the surface of a vessel of water. In the phototube, however, the cathode is not heated and the electrons are emitted by the action of light.

It has been found that electrons are emitted from metals in other ways than by heating. One of these, it will be recalled, was discussed in the preceding article when the principle of secondary emission was considered. In that phenomenon, electrons are "knocked" out of the plate by the impact of high-speed electrons traveling from the cathode.

Applications

Westinghouse Photo

Electrons can also be "knocked out" of substances by impinging X-rays or ultra-violet rays and by ordinary visible light rays. In the X-ray tube, high speed electrons impinging on the target produce X-rays. This process, curiously enough, is reversible, when a beam of X-rays is directed at a metal surface, electrons are emitted from that surface. Since X-rays are a form of electromagnetic radiation, differing from light only in terms of frequency, it is equally conceivable that ordinary light might under favorable conditions have the same effect.

And this, actually, is the case; many materials emit electrons under the influence of light. Copper, zinc, aluminum, barium, potassium and caesium all react to light in this manner but not all in the same degree, some materials emit electrons in this way much more easily than others and these are the substances used in phototubes.

A phototube, therefore, can be made by mounting in an evacuated tube an electrode which gives a large emission of electrons in the presence of light and another electrode to collect the electrons. The first, or photo-sensitive electrode, is called the cathode and the other the anode. The photo-sensitive material may be deposited on a curved metal plate as shown in Fig. 1 or as is frequently done in present day tubes, it may be deposited in the form of a very thin layer on the inner wall of the glass tube. When made in the latter form, a portion of the glass surface is left clear so that light can reach the inside walls of the tube.

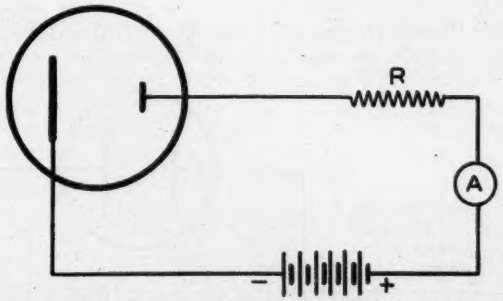


Fig. 2. The phototube circuit. Here a battery is connected in series with a resistor and a microammeter between cathode and anode The current in the circuit develops an e.m.f. across the resistor which can be applied to the grid of an amplifier tube if desired

If a battery is connected to the electrodes of such a device, so that the photo-sensitive element is negative and the other element positive, practically no current will flow through the evacuated space if there is no light falling on the cathode. If light is allowed to fall on the cathode, however, electrons will be emitted from its surface and under the influence of the potential existing between the electrodes, these will be drawn to the anode. Thus, a small current will flow in the circuit and the strength of this current is very nearly proportional to the amount of light falling on the sensitive surface. Consequently, if a graph is made to show the relation between the electron current and the incident light, the resulting curve will be very nearly a straight line as shown in Fig. 3.

The current delivered by a phototube of this type, or any other phototube for that matter, is very small, usually only a few microamperes. The curve shown in Fig. 3 gives the characteristic of the PJ-22 (G.E.) tube

and as will be seen, the maximum current is ten microamperes. As a consequence such tubes must be used in conjunction with other amplifier tubes.

An example of such a combination is shown in Fig. 4, which is a diagram of a circuit used to measure light values by means of the phototube. In this circuit the voltage developed across the resistor R_1, due to the current in the phototube circuit, is delivered to the grid of the triode VT_1. This causes the current in the triode plate circuit to vary in direct proportion to the emission in the phototube, which of course is dependent upon the amount of light falling on the tube. The current in the triode plate circuit is read on the milliameter in that circuit.

Ordinarily, in this type of phototube, a potential of 15 to 25 volts on the anode is sufficient to attract the electrons emitted; increasing this voltage above this value causes little or no increase in current. This is due to the fact that the number of electrons emitted is always quite small, and so even a relatively low potential is sufficient to attract all of them to the anode.

The current through the tube can, however, be increased by introducing a small amount of low pressure inert gas into the tube. Such a tube is called a gas filled tube, to differentiate it from the "vacuum" tube we have been considering. Thus, as in the case of thermionic tubes, there are two general classes of phototubes, *high vacuum* or simply *vacuum* tubes and *gas-filled* tubes. And, as in the case of thermionic tubes, the introduction of gas into the tube brings about an

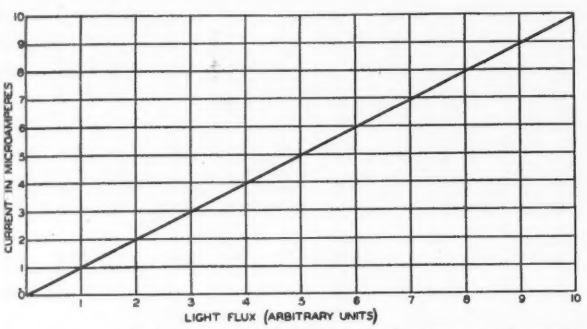


Fig. 3. Current-light intensity characteristic of a high vacuum phototube

increase in current through ionization of the gas molecules. This increases the original current by as much as ten times. The amount of ionization increases rapidly as the anode voltage is increased until a point is reached at which the discharge breaks into a glow discharge. This glow discharge, if permitted, rapidly destroys the tube so in practice it is always necessary to limit the anode voltage to a value below that at which this glow discharge occurs, and usually a series resistance is incorporated for additional protection.

In the manufacture of these tubes they are filled with an inert gas at a pressure of about 0.1 mm. after they have been thoroughly evacuated and the cathode has been properly sensitized. With argon which is a gas commonly used for this purpose, this pressure gives a mean free path for the electrons of about 0.25 cm. The ionizing potential of argon is 15 v., hence the potential gradient in the tube must be such that in moving 0.25 cm., the electron falls through at least 15 v. potential difference.

Although the process of ionization in gases was described briefly in Part VI of this series, the action may require somewhat further explanation here. In order that an electron may hit a gas atom with sufficient force to remove an electron from that atom, it must be traveling at a certain minimum velocity. For some gases, depending upon how loosely or firmly the orbital electrons are held, this velocity is greater than for others. For argon, this velocity corresponds to that which an electron acquires in falling through a potential of 15 v.

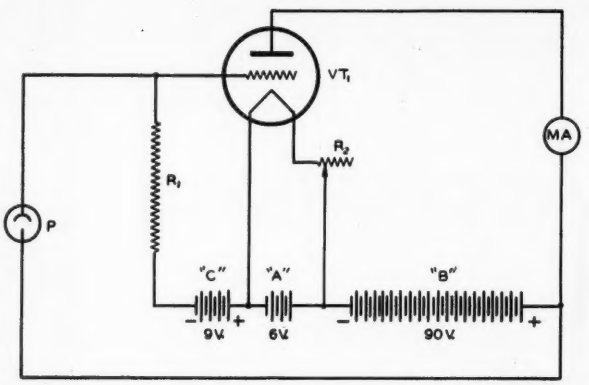


Fig. 4. Circuit diagram for measurement of variable light values with a phototube. Resistor R_1 may have a value of from 2 to 10 megohms

To illustrate this, consider a glass bulb, as shown in Fig. 5, with two plates separated by a distance d and containing a small amount of argon gas. Assume that an electron starts from plate A under the action of potential E. Unless E exceeds the ionizing potential of the gas, there is no possibility at all of the electron acquiring sufficient speed to produce ionization even if it fell unimpeded from one plate to another. It is obvious therefore that the voltage E must be above the ionizing potential of the gas in the tube—in the case of argon, at least 15 v.

It can be shown, however, that if the tube is filled with gas at atmospheric pressure and with the electrode only a centimeter or so apart, a potential difference hundreds of times as great as the ionizing potential of the gas can be impressed across the electrodes without producing appreciable ionization in the gas. This is due to the fact that the electron on its way from one plate to the other does not move very far before it collides with one of the numerous gas atoms in its path and so loses practically all the velocity it had gained. Then it will have to start all over again and then before it acquires sufficient velocity to produce ionization it may collide with another atom and again lose all its velocity.

The "mean free path" of an electron, therefore, depends upon the average distance between the atoms of

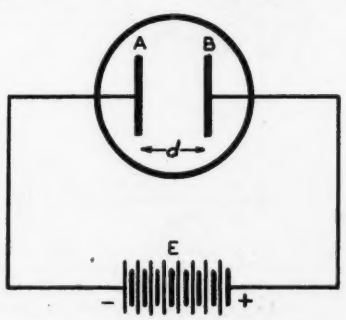


Fig. 5. Circuit and tube to illustrate the effect of "mean-free-path" in gases

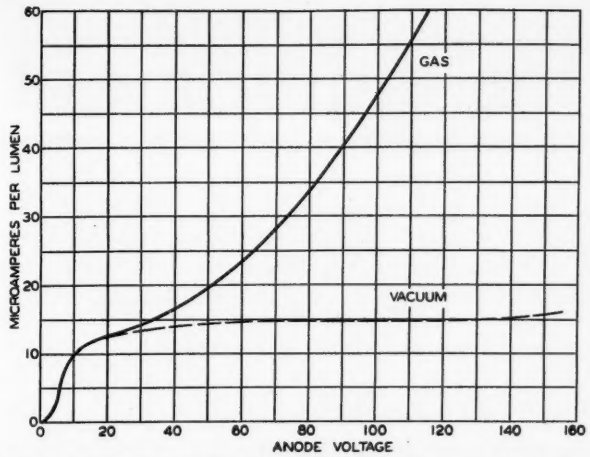


Fig. 6. Current-voltage curve of a gas-filled phototube. The lower portion of the curve corresponds to that of a high vacuum tube. It is essentially linear until the saturation value is reached. Then as the anode voltage is increased ionization sets in and the current again rises rapidly. The curve for a high vacuum tube under the corresponding condition of voltage is shown dotted

gas, and this, it is well known, depends on the gas pressure. At atmospheric pressure the atoms are about one millionth of a centimeter apart so it might seem that the electrons could scarcely move at all before colliding with a gas atom. This, however, is not true because the gas molecules are so small that even at this distance there is relatively ample space between them.

As the gas pressure is reduced, the mean free path of the electron is increased. At 0.1 mm. pressure with argon, as already stated, the mean free path is about 0.25 cm. and since the ionizing voltage of argon is 15 v. an electron will have to fall through at least 15 v. potential difference in a distance of 0.25 cm. to effect ionization.

So much for the relation between gas pressure and ionization. While a knowledge of this is not strictly essential in the use of the phototube, it adds to one's understanding of the subject as a whole and it is for that reason that it is presented here. The presence of gas in a tube obviously alters a phototube's characteristics, causing it to depart from the linear relation shown in Fig. 3.

A typical voltage-current curve for a gas-filled tube is shown in Fig. 6. The current, it will be noted, rises rapidly to the saturation value of the tube as a vacuum tube.[1] This saturation value of current holds, as the anode voltage is increased until ionization sets in, and here the ionized gas adds its current carrying capacity so that the anode current increases to several times the true saturation current of the tube. As already mentioned, if too intense an ionization is employed, the tube becomes unstable and it may set up a glow discharge which persists independent of the illumination. The excessive bombardment of the cathode surface under these conditions results in its rapid and permanent deterioration. Usually an amount of ionization which gives an anode current from five to ten times the value of the photoemission is as much as can be safely used.

Although the glow discharge referred to above must be avoided in the operation of the ordinary gas filled phototube, a tube of special design has been developed which utilizes this glow discharge effectively. This is the photoglow tube developed by D. D. Knowles. This tube is similar to the ordinary gas filled phototube, but the gas pressure is considerably higher. They are operated with sufficient voltage between the electrodes so that the electron flow due to the photoelectric effect will ionize the gas and initiate a glow discharge. Since this glow is essentially an arc, with a constant arc voltage, the current through the photoglow tube bears no relation to the degree of illumination; it is limited only by the impedance in series with the tube. This current is usually of sufficient magnitude to operate a magnetic relay without the use of amplifiers.

The characteristics of a typical photo-glow tube are shown in Fig. 7. As will be noted, this tube has the property of locking in when energized from an a.c. source so that if the illumination is increased to a point above the start curve and then decreased but not below the stop curve, the current will continue. On alternating current, of course, the current stops at the end of every half cycle but unless the illumination is reduced to a point below the stop curve, it will be re-established at each alternate half cycle. This characteristic is useful in maintaining the current after it is started by a transient increase in the illumination.

[1]By saturation value, of course, is meant the point at which the anode voltage is sufficient to attract all of the emitted electrons to the anode.

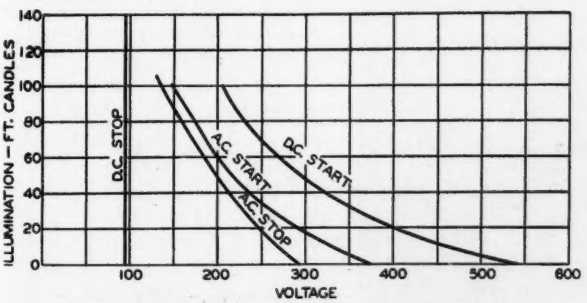


Fig. 7. The characteristics of the photoglow tube

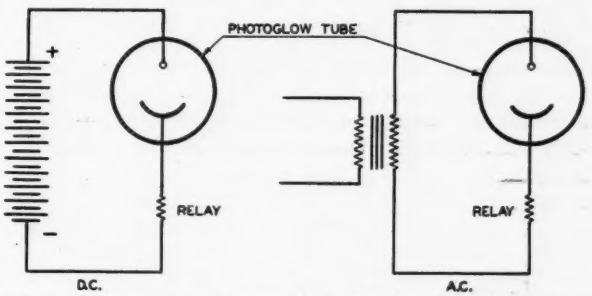


Fig. 8. Circuits showing the use of the photoglow tube with direct and alternating current

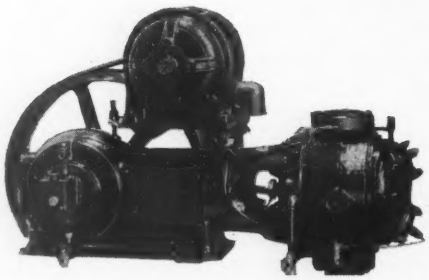
Such tubes will carry as much as 5 ma. and they are designed for use where only occasional breakdown is encountered. Their field of application at present is quite limited and they must be regarded largely as a special form of the phototube in which we are interested.

To recapitulate then, there are two general types of phototubes: first, the high vacuum type which has a decidedly linear characteristic but a low current capacity, and secondly, the gas-filled type which has a much higher current capacity but in which the voltage-current curve departs from a linear relation. The

(Continued on p. 305)

Motor and Control Equipment

PART II **A discussion of the type of control available for the various motors considered in the preceding article. Describing the equipment and the methods and rules governing its installation.**



By J. M. BARTHOLOMEW

Engineering Department, Sullivan Machinery Co., Michigan City, Indiana

HAVING CONSIDERED the various types of motors available for compressor drives, we shall now discuss the question of motor control. The following discussion covers the more usual type of motor control or motor starting switch. No description of compressor control or auxiliary control devices will be included since this would of course vary with each different installation. There are four general classifications of motor controlling devices which are as follows: (1) Full voltage manual starter, (2) Full voltage magnetic starter, (3) Reduced voltage manual starter, (4) Reduced voltage magnetic starter.

For synchronous motors and for slip-ring motors a combination of two of the above types is available; this is known as the semi-magnetic starter.

Squirrel Cage Induction Motor Control

The manual full voltage starter for an induction motor will consist of a safety switch which is merely a 3-pole line switch with fuses, or will consist of any of various types of small circuit breaker type switches with overload trip coils, or other overload protective features. This starter is generally recommended for motors up to 5 hp. In these smaller sizes the switch is compact and can be mounted on the compressor or on the motor which it controls. Above 5 hp. the switch usually becomes large and cumbersome, necessitating wall or post mounting and the full voltage magnetic switch is generally recommended.

The full voltage magnetic starter, frequently referred to as a full voltage automatic starter or line-starter, consists of a solenoid operated contactor with pilot circuit controlled by a push button, pressure switch or other device. The usual form of this starter includes a thermal overload device which has characteristics such that it will trip the contactor in event of continued overload which would overheat the motor. These so-called thermal overload relays can be selected to fit the particular motor and the motor condition.

These thermal overload devices are not designed to handle short circuit currents such as might occur if there was a short in the wiring between the starter and the motor terminal. For this reason it is advisable to use fuses in addition to the full voltage automatic starter and these are usually supplied in the form of a

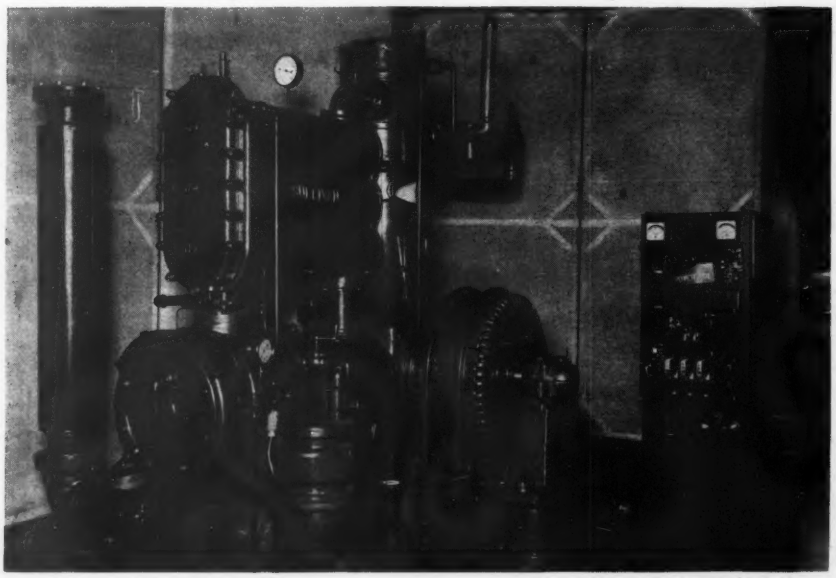


Fig. 1. Heavy duty compressor with direct connected synchronous motor and full voltage magnetic starter

safety switch which will be mounted on the wall at the point where the leads for the compressor are connected to the main shop distribution wiring. Regulations require that a branch circuit to a machine shall be fused within a definite distance from the main distribution line so the safety switch serves a double purpose of protecting the thermal-overload relays against short circuit conditions and protecting the branch wiring in accordance with Board of Underwriters specifications. This fused safety switch may also be in the form of any of the numerous panel distribution centers now being offered by manufacturers of wiring specialties.

The manual reduced voltage starter sometimes called auto starter, or hand compensator, is usually in the form of a double throw switch. Moving the lever to one position connects the motor to the line through an auto transformer which reduces the voltage at the motor terminals and consequently reduces the starting current and the starting torque. A quick movement through the off position to the run position throws the motor on full voltage after the operator has decided that the motor is sufficiently accelerated to allow full voltage to be impressed on the winding. This form of starter usually has a latch which prevents throwing to the run position direct from the off position. The same latch is used to hold the handle in the run position and arrangements are made by means of an overload relay to release this latch if an overload is impressed on the motor. The starter generally is arranged such that it will drop out in event of low voltage. To stop the motor the usual form of this manual reduced voltage starter includes a push button which breaks the circuit to the latching device, releasing the latch and allowing the handle to return to the off position.

This reduced voltage manual starter is quite generally used for induction motors of 40 to 100 hp., particularly in plants where it is desired to keep the first cost of installation as low as possible. There are few objections to this type of starting equipment, particularly in shops where the plant electrician has a reasonable skill in repairing and caring for such apparatus.

The reduced voltage magnetic starter, also called a compensator starter, or an automatic compensator starter, has the same general principle as the reduced voltage manual starter except that the starting contactor and run contactor are magnetically operated and a definite time relay is used to allow the motor to operate a definite time on reduced voltage before throwing over to the run contactor, and consequently to full voltage. This contactor has a thermal overload relay similar to the relay used on the full voltage magnetic starter and it must also have a safety switch or fuses in the incoming line to protect this thermal relay against short circuit condition.

A magnetic reduced voltage starter is of course required for all operations where the starting and stopping of the motor will be governed by a pressure switch or other device independent of the operator. If the unit is arranged for remote control the magnetic starter is desirable to avoid necessity of the long power leads required to permit use of a manual type starter. The majority of installations using the magnetic reduced voltage starting equipment are those installations using high voltage (2200 v. and above), for locations where skilled help is not available and for plants where the appearance and simplicity of the wiring, convenience for the operators, general plant policy or other factors indicate the use of the magnetic reduced voltage starting equipment.

Wound Rotor Induction Motor

In starting a wound rotor or slip-ring induction motor it is necessary to connect the primary winding to the supply line with all of the resistance in the secondary motor circuit. The motor is then brought up to speed by cutting out this resistance in successive steps. Due to the amount of reactance in this type of motor, the primary lines can be connected to the supply line without the use of any type of voltage reduction provided, of course, the resistance is inserted in the secondary winding.

Manual control for this type of motor consists of a hand operated line switch of the safety switch type, or a suitable oil or air circuit breaker. Manual control for the secondary will consist of a drum switch and a suitable resistor. The circuit breaker type of primary switch is much preferred because the low voltage device can be easily applied to this switch to trip off the motor in event of low voltage. In addition, the usual circuit breaker is supplied with an overload trip which gives the equivalent of the fuse protection for overload included in the regular line switch. The usual drum switch includes a set of contacts which may be used with the low voltage relay on the primary switch to prevent starting the motor except when the drum switch is in the starting position.

The above manual control is used in by far the largest number of installations where a compressor is driven by a slip-ring induction motor.

Magnetic starters are used for those installations where the motor is to be started and stopped by means of pressure switch or other control device of this type. Because of the high cost of automatic or magnetic control the application is practically limited to this one condition, although there are a few cases, where, due to plant policy only automatic starting equipment will be purchased.

On construction projects the manual control is found very satisfactory since the oil circuit breaker can be purchased for 2200 or 4000 v. at reasonable prices.

The type of control which may be referred to as semi-magnetic is frequently used for slip-ring motors. This consists of a full voltage magnetic starter for the

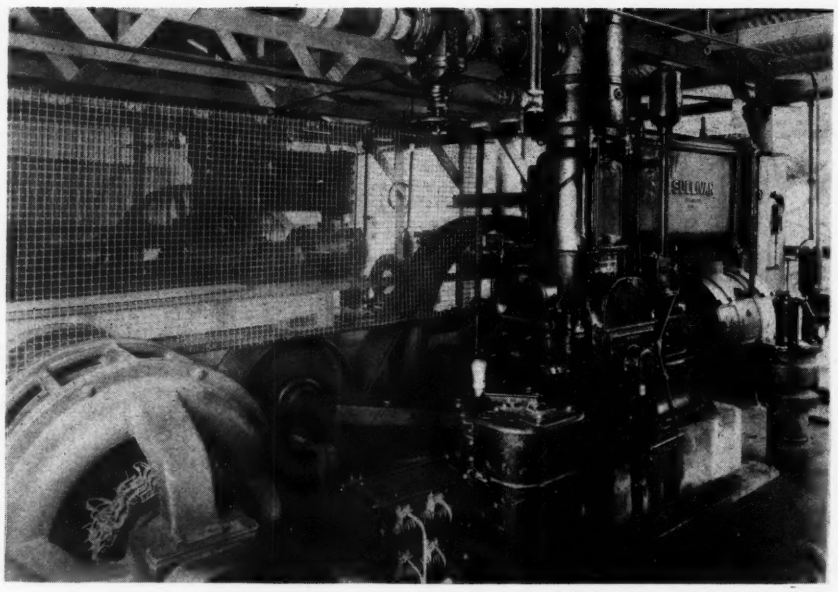


Fig. 2. Heavy duty compressor with slip ring induction motor and manual control

primary winding together with the drum switch and resistor for the secondary winding. This operates in exactly the same way as the oil circuit breaker except that a contactor is used in place of the circuit breaker. Temperature overload relays offer good protection against continued small overloads which might eventually damage the motor but which do not reach sufficient proportion to trip the instantaneous type of relay used on circuit breakers. For slip-ring motors of large horsepower at 220 v. the cost of the magnetic contactor becomes excessive. Also, the cost of a magnetic contactor at 2200 or 4000 v. is enough greater than the cost of a suitable circuit breaker to limit its use in this field.

Synchronous Motor Control

When a synchronous motor is started the field winding is shorted usually through a resistor, and the squirrel cage or damper winding is used to bring the motor up to synchronous speed. As soon as the motor is within three or four per cent of synchronous speed, field is applied and the motor "pulls into step." Unnecessary delay in applying field throws an additional strain on the starting winding because of heating. The synchronous motor control will usually have the field applied by means of a definite time relay and a field applying contactor. A full manual type of starter for a synchronous motor is seldom used.

The high speed synchronous motor with its characteristic high inrush current requires a reduced voltage starter for sizes above about 7½ hp., and for this purpose we find a starter similar to the squirrel cage induction motor manual type starter except with the addition of the relay and field applying contactor. This starter is termed a reduced voltage semi-magnetic starter. The reduced voltage magnetic starter for the high speed motor consists of two contactors, a starting contactor which connects the motor to the line through auto transformers and a run contactor which applies full voltage. Field is applied by means of a time relay and contactor.

The large slow speed synchronous motor for compressor drive is a motor having relatively low starting current and may therefore be started on full voltage except in very special cases. If this starter is of the manual type the field should be applied automatically and the starter will be referred to as a semi-magnetic starter. Alternating current is applied at full voltage by means of a circuit breaker or other type of line switch, and field is applied by means of a time relay and a magnetic contactor. This starter is simple and rugged and is the usual type of starter purchased for semi-permanent installations or for jobs where it is necessary to keep down the first cost of the installation. Auxiliary apparatus such as exciter field rheostats or main motor field rheostats will be supplied depending on whether motor generator sets or shop lines furnish the power for the direct current field.

Due to low cost and widespread use the "Industrial Type" of full voltage magnetic starter is the control most often used for the large slow speed synchronous motor. The usual construction includes main line contactor of the air break type for low voltages and of the oil circuit breaker type for 2200 v. and above. This starter will be supplied for most industrial installations. Protective features prevent overload of the squirrel cage winding during the starting period and power factor relays stop the motor if low power factor indicates loss of excitation, failure to synchronize or other conditions which might damage the motor. Overload and under voltage protection are included and the control circuit on most panels can be arranged so that the motor will resynchronize and continue running after line voltage interruptions of short duration.

In generating stations, or in the engine rooms of plants, such as refineries where special conditions must be met, the switch gear type of synchronous motor starter may be used. Such installations are usually planned by Consulting Engineering firms, and definite specifications for electrical equipment are established. About the only general rule which can be set down is

that special control can be designed to meet almost any operating condition.

Direct current motors above one and one-half horsepower are usually started on reduced voltage to avoid the high inrush current which would result from applying full line voltage. Although line voltage disturbances and momentary heavy overloads on feeder circuits would be undesirable, the most harmful effect of trying to start direct current motors on full voltage is the damage to the commutator and brush rigging on the motor which results from trying to commutate current greatly in excess of the rated full load current.

The manual reduced voltage starter generally consists of a rheostat by means of which reduced voltage and limited starting current is applied to the motor, the amount of resistance being reduced in definite steps to bring the motor up to speed. The final step shorts out the resistance entirely and the motor operates on full voltage. This starter is built in a wide variety of types and some types include overload and under voltage protection, some include contactors to make and break the circuit, etc. It is used principally for small stationary installations where starting will be infrequent, or where the operation and maintenance is in the charge of experienced and conscientious supervisors.

The principal weakness of the manual reduced voltage starter is the tendency to burn and damage the contact points, particularly at the hands of a careless operator, or as the handle drops back to the off position when released by low voltage or overload. (The latter has been corrected on some starters by the use of a contactor.)

Reduced voltage magnetic starters consist of a main line contactor to connect the motor to the line through a resistor and accelerating contactors to short out the resistance in definite steps. The timing sequence is regulated for best motor and starter performance. Protective features prevent starting until accelerating relays have opened to "cut in" the resistance. Under voltage and thermal overload protection are standard features.

When used on a portable machine at the end of a long cable it is advisable to have instantaneous overload protection and some starters include this feature. If not included as part of the starter an air break circuit breaker may be included with the electrical equipment. This feature serves to protect the machine against short circuits in the wiring. If for any reason the d.c. motor should lose its field while the compressor was unloaded it would start to "run away" and under this condition a main line contactor in poor repair might fail to interrupt the current and "weld in." The operator must trip the air circuit breaker, pull the plug on the trailing cable or open a disconnect switch, one of which should be a part of the control on a direct current portable machine.

A type of starter used for starting direct current motors which may be roughly classed as reduced voltage magnetic, consists of a relay to apply a heavy field to the motor, then after a definite time interval close a contact to apply full voltage to the motor armature. The heavy magnetic field acts as a reactance to the build-up of current in the armature winding and thus limits the starting current. This arrangement would be particularly suitable for conditions where it was necessary to start the compressor against load.

Semi-magnetic reduced voltage starters for direct current motors consist of some type of hand operated circuit breaker to connect the motor to the line through a resistor, and accelerating relays to bring the motor up to speed. The circuit breaker affords overload protection, and if equipped with a trip coil, under voltage protection also. Simplicity and compactness lead to the use of this starter for some applications where the full magnetic starter is not required.

Columbia to Expand Engineering School

A FIVE-YEAR plan for expanding the physical facilities of the Columbia University School of Engineering at a cost of approximately $2,500,000 is outlined by Dean Joseph W. Barker in his annual report to President Nicholas Murray Butler.

The program, which calls for the construction of two new buildings, would involve no increase in the engineering student body, Dean Barker said, but would "care for the technical advances which have been made in the various fields of engineering in the past three decades." Provision for future growth would be made by constructing an additional building at some later date on a site at 120th Street and Broadway already reserved by the trustees for engineering.

"To develop and to hold a great staff for the instruction of students, for fundamental research, and for scholarly exposition of engineering progress, we must offer proper and reasonable facilities for instruction and for research," Dean Barker explained. "It is in the physical plant that our school is weak, and we must now undertake the rebuilding and re-equipping of our facilities.

"The most pressing need is for laboratory space for the Electrical and Mechanical Engineering Departments. This can be satisfied by construction fronting on the Green between Havemeyer and University Halls and connected with the present Engineering Building. Moving the electrical and mechanical laboratories into this new space will permit expansion in the Engineering Building and in Havemeyer Hall of the space devoted to civil, chemical, and industrial engineering and hence will offer immediate relief to those departments which are most definitely crowded.

"This first construction and the necessary equipment will involve nearly $1,500,000 and is urgently required to give relief from present conditions. The second phase of the program is a new building above part of these laboratories to house the offices and classrooms of the Departments of Electrical and Mechanical Engineering.

"The Department of Mechanical Engineering is now housed in the Pupin Laboratories and is occupying space needed by the Physics Department. This proposed building with its equipment will require nearly $1,000,000. Therefore it is evident that within the next five years we must raise nearly $2,500,000 of new funds to care for the pressing problems of our school.

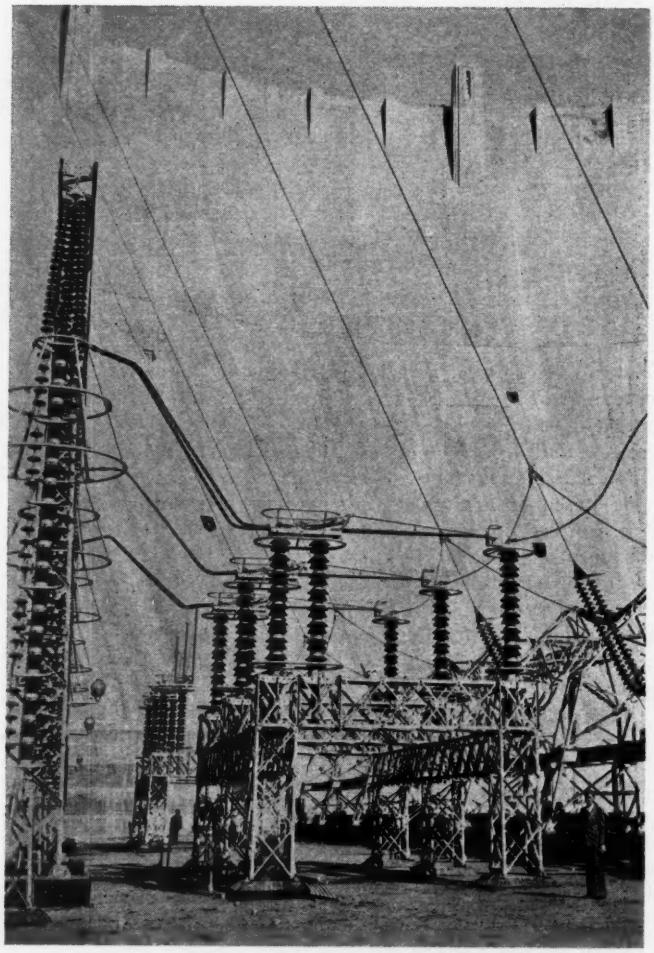
World's Largest "Disconnects"

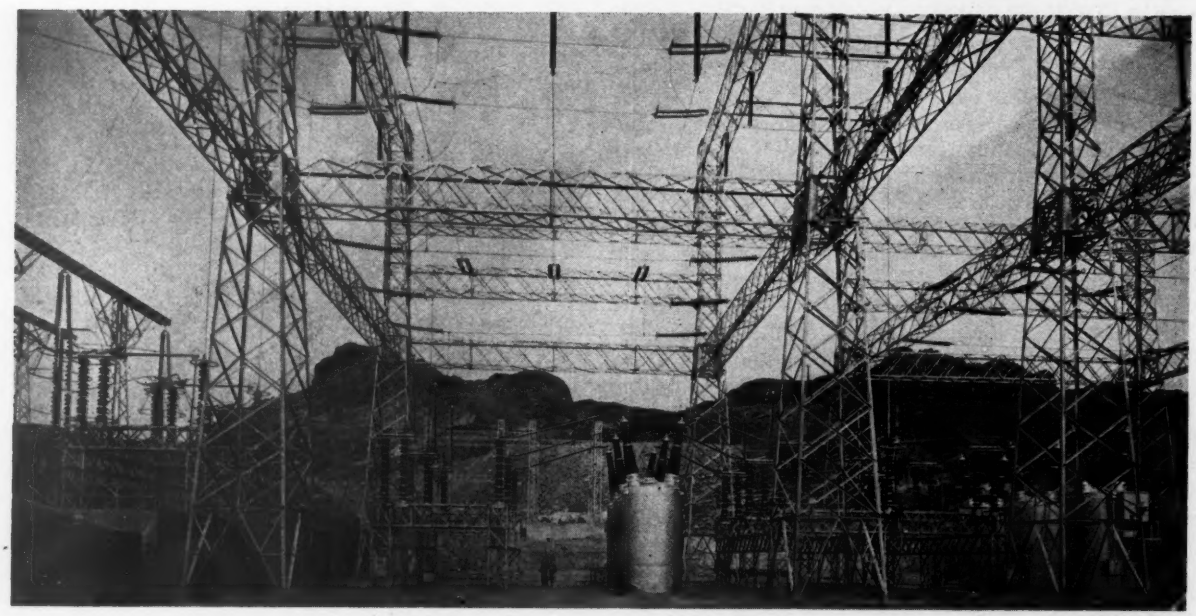
THE ACCOMPANYING PHOTOGRAPHS show views of the largest disconnecting switches ever built as they are installed at Boulder Dam. Designed to operate at a line voltage of 287,000 v. they are by far the largest switches ever built. In tests recently conducted at Stanford University the switches were subject to voltages as high as 850,000 v. One of the most rigid tests was to determine definitely that they will not be subject to visible corona. No visible corona is permissible since it would seriously interfere with the power system radio-telegraph service.

The switches are all triple pole switches, most of them single throw but with a number of double throw units. The latter have a base length of 39 ft. When opened the switches stand 27 ft. high and they weigh 55,000 lb. each. Each insulator pedestal of which there are 15 to a switch weighs more than a thousand pounds. The cost of the single throw switches is $10,000; that of the double throw units, $19,000.

The switch contacts are made of chemically pure silver.

In the view below, the oil circuit breakers are shown in the center of the picture between the two banks of disconnects. These also are the largest of their kind in the world; in fact, practically everything connected or associated with the Boulder Dam Development is the largest in the world.





Employes' Rights in Industrial Injuries

To avoid liability for injury to an employe it is incumbent upon the employer to prove that the injured person was responsible for the accident. Responsibility rests with employer in most cases of injury due to use of either obsolete or little understood experimental equipment.

By Leo T. Parker
Attorney-at-Law

GENERALLY speaking, the value of legal decisions, pertaining to injuries to employes, is dependent upon answers to three questions, namely, (1) Were the decisions rendered recently? (2) Were the opinions written by the higher courts? (3) Is the cause, outcome and legal reason for each decision clearly understandable by the average layman?

If the decisions are old, the illustrated law is not dependable because, in many and very frequent instances, newly decided cases overrule the law established by older cases. Moreover, if the decisions are rendered by lower courts, the cause and outcome of the litigation is not important because the entire opinion may be reversed by the higher court upon appeal by the adverse party.

Higher courts in different localities have rendered unusually important decisions involving injuries to workmen. Particularly, for the reason that knowledge of the cause and outcome of these cases should enable power plant engineers to operate their plants with less likelihood of financial losses from this source, and also for the purpose of reducing injuries to employes, I shall review the most important of these decisions.

Scope of Employment

Probably the outcome of the majority of litigations, involving injuries to employes, is dependent upon whether the injury was sustained as a result of the employes' own negligence. This is an important point because, obviously, employes are likely to exercise a higher degree of care if they are informed that damages are not allowable for injuries resulting from contributory negligence. Therefore, legal knowledge on this subject is adapted to reduce the amount of damages normally paid by employers, as well as benefit employes by lessening their injuries.

What Is Contributory Negligence?

It is well settled that an employe never is entitled to damages for injuries sustained as a result of his own carelessness. Contributory negligence involves some fault or breach of duty on the part of the employe. Since it is ordinarily his duty to take some precaution for his own safety when engaged in a hazardous occupation, contributory negligence is sometimes defined as a failure to use such care for his safety as ordinarily prudent employes in similar circumstances would use.

On the other hand, the assumption of risk, even though the risk be obvious, may be free from any fault or negligence on the part of the employe. The risks may be present, notwithstanding the exercise of all reasonable care on his part. Some employments are necessarily fraught with danger to the workman—danger that must be and is confronted in the line of his duty.

Therefore, it is generally held by the courts that an employe assumes the risks of the dangers which are normally and necessarily incident to the occupation and of other dangers of which he becomes aware and appreciates. Also, employes assume the risks of such dangers that are so open and obvious that an ordinarily prudent person under the same circumstances would have observed and guarded against.

For the reason that considerable doubt usually arises on the question of whether or not an injury was sustained as a result of contributory negligence on the part of the employe, the question is decided by a jury after carefully weighing all details of the testimony. As a rule the higher court will not disturb a prudent decision rendered by a jury. An example of this phase of the law is found in the case of Dick v. Atchison, 287 Pac. 538.

The facts of this case are that an engineer was seriously injured. The jury considered the testimony and rendered a decision in favor of the injured employe. The employer appealed to the higher court contending that the employe was not entitled to recover damages because, according to legal rules, he assumes the ordinary risks of his employment. It is interesting to observe, however, that the higher court affirmed the lower court's decision, stating:

"The respondent (employe) not only assumed the risks and dangers incident to his work but also extraordinary risks 'caused by the employer's negligence which are fully known and appreciated by him or which are so obvious that an ordinarily careful and prudent person would, under the circumstances, have observed and appreciated them' . . . It is a sufficient answer to this assertion to say that we could only apply the doctrine here as a matter of law by assuming a state of facts contrary to that which the jury evidently believed to be the true circumstances."

Employer Must Provide Safe Working Place

Of course, all employers are expected by the law to exercise reasonable care in maintaining the equipment, with which employes work, in good condition. Therefore, the employer is liable who negligently permits

mechanism to get out of repair, and an employe, not realizing the danger, is injured as a result thereof.

On the other hand, it has been frequently held that an employer is not liable for injuries sustained by an employe, where it is disclosed that the latter was aware of the defective condition of the mechanism which caused the injury, and failed to notify his employer that repairs were required.

If the defect is of such character that the employe failed to discover it, then the court will investigate the circumstances surrounding the accident to determine whether or not the employer exercised "ordinary care" to inspect or have inspected the mechanism with the object of discovering and remedying the defect.

In the case of Fowler v. Caroline, 133 S. E. 188, the higher court explained that before an employer is liable for injuries sustained by an employe: (1) the instrumentality causing the injury must be defective, or (2) the employer must know of the defect, or be negligent in not discovering it and making the needed repairs, or (3) the employer gives assurance to the employe that the instrumentality is safe, or (4) the work must be done under the supervision of the employer and according to his instructions, or (5) if the employer, having either express or implied notice of a defect, promises to repair or procure a reasonably suitable instrumentality and fails to do so.

It is important to know that the duty of an employer to use ordinary care to provide his employes with reasonably safe appliances and machinery does not require him to furnish the newest and best appliances. In other words, if the employer furnishes appliances that are customarily used by ordinarily prudent persons in the same business, he is not negligent. However, such custom must be uniform and if there is any material variation therefrom on the part of the employer, the question of the employer's liability must be decided by a jury.

For example, in the case of Birdsong v. Jones, 30 S. W. (2d) 1094, it was shown that an employe, who was injured, sued his employer for damages and proved that the instrument which caused the injury was not equipped with a safety guard usually used on similar machines. Therefore the jury held the employer liable and the higher court upheld the decision.

It is interesting, however, to compare the case of Knott v. Missouri Works, 299 Mo. 613. Here an employe was injured by a machine. There was testimony that if the machine had been supplied by the employer with a safety guard the injury would not have occurred. Although this guard could have been attached at moderate cost and had been in use for 2 yr. in numerous other cities, it was not used in the city in which the employe was employed, nor in the state. It was not proved that it was the common and general custom of employers to use a machine equipped with a safety device, nor was it shown that a machine so equipped with such a device was in common and general use at the time. The jury decided that under these circumstances the employer was not liable for the injury.

Injury Caused by Simple Tools

Another important point of the law is that it is deemed negligence for an employer to furnish a tool which is not reasonably safe to be used by an employe. On the other hand, the law is established that where an employe is supplied with a simple tool having open and glaring defects and a reasonably prudent person would not undertake to use it, then the employe is contributory negligent and he is not entitled to damages for an injury sustained.

For illustration, in Nolen v. Halpin, 29 S. W. (2d) 215, it was shown that an employe was injured while he was using a hammer, the head of which was flat on one end and shaped like a hatchet on the other. The employe was experienced and understood the use of the tool, but he sued for damages on the contention that the foreman had supplied him with a rusty tool which caused the injury. However, the court held the employe not entitled to recover damages, saying:

"This failure to use ordinary care is negligence and if he sues the master for the master's neglect in furnishing an unsafe tool, the master may respond and say the tool was a simple device, and any ordinary person could have seen and known the defects thereof, and in using it in that condition you have been guilty of negligence which contributed to your injury, and you cannot recover."

Law of Fellow Employe

It is important to know that the majority of courts are in accord with the rule that an employer is not liable in damages for an injury sustained by a workman as a result of a fellow employe's negligence. Obviously, however, the same rule does not apply where the injury is caused by a superior, as a foreman, because fellow employes legally are employes of the same classification and rank.

In State v. Haid, 18 S. W. (2d) 479, an employe was injured by negligence of a fellow employe. The injured workman sued to recover damages, but the court refused to hold the employe entitled to a recovery, saying:

"Two employes of the same master were engaged in a common work or labor. The fellow servant negligently started the machine in motion without a warning to his fellow employe . . . Their employer could not be held to answer for an injury to one of them, caused by the negligence of his fellow servant . . . This court has lately followed the ruling that an employe of the same master cannot recover for an injury caused by the negligence of a fellow servant."

On the other hand, the law is well established that foremen, or other superiors, are bound to exercise ordinary care to protect employes under them against injury. This law is applicable under all circumstances.

For instance, in State Co., 20 S. W. (2d) 494, it was shown that an employe was directed by a superior to perform certain work. The employe was seriously injured and sued for damages. The testimony disclosed that the injury was caused by a defect which should have been discovered by the employer's foreman.

The lower court held the employe not entitled to damages. In view of the fact, however, that the foreman had failed to discover the defect causing the injury, the higher court reversed the decision, stating the following important law:

"The employer is required to exercise ordinary care to furnish to his employe a reasonably safe working place, and must take such precautions for the safety

of his employes as ordinarily prudent men would take in like circumstances."

When Employe Is Authorized to Control Workmen

Frequently, the outcome of a suit by an injured employe for damages depends upon who directed the employe to perform the work resulting in the injury. Generally speaking, an employer is liable if the injury occurred as a result of his negligence and the injured employe was acting under the direction of one whom he had good reason to believe was his superior.

For example, in Moore v. James, 27 S. W. (2d) 765, it was proved that an employe was injured while performing work under the direction of another workman named Webster. The employer attempted to avoid liability on the grounds that Webster was a fellow employe who had no authority to direct or control the injured workman. Since it was proved, however, that prior to the injury a superior had stated to the injured employe that Webster would show him what to do, the court held the employer liable, saying:

"If the master could not be held liable for any act of a vice-principal unless that act was authorized, then the master would never be liable for the vice-principal's acts unless he himself, acting personally, committed a wrong . . . While the authority of the superior servant must come either from the master or from one standing in the place of the master . . . a servant who has been duly authorized by an admitted agent or vice-principal of the master may become a superior servant for whose negligence the master is liable . . . It further appears that Webster gave orders whenever the general foreman was absent, and that he gave the orders which were obeyed at the time plaintiff was injured."

How Damages for Injuries Are Estimated

Under ordinary circumstances if negligence of an employer results in an injury to his employe, the latter is entitled to an amount of damages to compensate adequately the injured employe for loss of the income as a consequence of the injury.

For illustration, in Roads v. Kelleher, 26 S. W. (2d) 764, it was disclosed that an employe was seriously injured when a heavy weight fell upon his foot, requiring the amputation of two-thirds of his left leg below the knee. The injury necessarily confined him to the hospital for a period of five months. He sued for damages and proved that he was a laborer who earned forty cents an hour and worked regularly eight hours a day. The lower court held the employe entitled to recover $17,500 damages. The employer appealed to the higher court on the contention that the judgment was excessive. Nevertheless the higher court upheld the lower court's decision, saying:

"We infer from the evidence that he earned about $900 a year . . . Plaintiff was deprived of the power to labor and to earn a living during the rest of his life through the negligence of defendant. A principal of $15,000, drawing 6 per cent interest, was necessary as the basis for an income of $900 a year. The present value of $15,000, at fifty-two years of age, is about $8,800, and that income plaintiff is held to have lost . . . Moreover, the crushing of the foot and the operations to save his leg, as well as the amputation, seemingly were agonizing. Under the facts and circumstances of this case, we do not think the verdict was excessive."

Workmen's Compensation Laws Cannot Be Waived

It is well to know that in the majority of states employers are not permitted to settle a claim for injuries, unless the terms of the settlement conform with the provisions of the workmen's compensation laws.

For instance, in Comingore v. Shenandoah Co., 226 N. W. 124, it was disclosed that the dependents of a deceased workman, who was killed while performing his regular duties, compromised with the company for $4500. This settlement was approved by the industrial commission.

In view of the fact, however, that this amount was less than that specified in the compensation laws, the higher court held the agreement void, stating the following important law:

"In law no contract, rule, regulation, or device whatsoever shall operate to relieve the employer for any liability created by the Workmen's Compensation Act . . . It is further provided that no employe or beneficiary shall have the power to waive any of the provisions of this act in regard to the amount of compensation which may be payable to such employe or beneficiary, to whom the act applied . . . The Industrial Commission has power to approve an agreement only when the terms of such agreement conformed to the provisions of the act."

At a recent meeting in Cincinnati, presided over by J. E. Tobey, manager, fuel engineering division of Appalachian Coals, Inc., on Marketing Steam Coals, papers were presented by H. A. Glover, Cincinnati, assistant to the president, Island Creek Coal Sales Co., by B. E. Tate, Dayton, chief engineer of power, National Cash Register Co., and by E. C. Payne, New York City, manager, fuel consultation service, Consolidation Coal Co.

Speaking on Selecting Coal by Steam Cost Evaluation, Mr. Glover maintained that, if steam coals were scientifically selected and applied on the basis of proven steam cost in any given plant, millions of dollars of saving would be made each year to both dealers and consumers. Requirements enumerated were a consideration of percentage of coal under ¼ in. in size, as actually fired, of uniformity, of burning characteristics, fusion and heat content; and, in operation, tests of burning and heat utilization, adjustment of equipment, grate and furnace maintenance, and the human factor. Buying of coal by careful selection of the one coal giving lowest steam cost, rather than by price and rigid specifications was advocated as the method to bring about the millions of savings.

Mr. Tate, discussing Use Value vs. Scientific Characteristics of Coals for Steam Generation, emphasized the importance of low plant operating cost, including maintenance, labor and fixed charges. Use value of coals in a given plant should be determined, then they may be compared as to scientific analysis.

As to Relation of Burning Equipment to Coal Selection, Mr. Payne advocated complete cooperation of consumer's engineers, consulting engineer, fuel specialist, equipment manufacturers and coal producers from the first inception of a plant.

Coal Consumption Cut by Heat Control

Store Heating System Modernized for Economy and Comfort

Charles J. McClinch,
Chief Engineer, Howland Dry Goods Co.

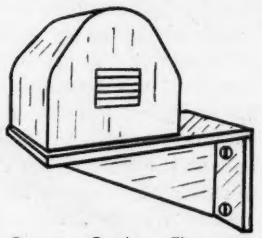


Fig. 1. Outdoor Thermostat "The brains of the control"

ENGINEERS in charge of industrial plants, buildings and institutions which contain many square feet of radiation surface for heating, should not lose sight of the opportunities that are available to make substantial savings in fuel consumption. It is fundamentally important to make systematic inspections during the summer months to repair any leaking joints, repack valve stems on main and branch valves, check for trapped laterals which should be regraded, inspect radiator trap interiors, check traps at bottom of supply mains and dirt pockets for faulty conditions.

Some buildings, no matter how expert was the designer of the heating system, suffer to some degree from an inequality in temperature in various parts of the system. The reasons for this vary in different ways but they may be roughly summed up by the statement that the circulation is unbalanced. The steam reaches some radiators sooner than others, due to surrounding conditions, dissipate more than their share of heat, leaving other parts too cold; or the circulation of cold and warmed air by forces of gravitation changes the temperatures desired. The occupants of a building try to overcome these conditions by turning on or off the radiator valves, or by opening or closing the windows, which produces dissatisfaction and wastes valuable heat. In sections of a building where overheating occurs they are likely to contract headaches and become sluggish, both mentally and physically. It is a well known fact that in most cases people work better and feel more active if the inside temperature is kept at about 68 to 70 deg. F. during the heating season.

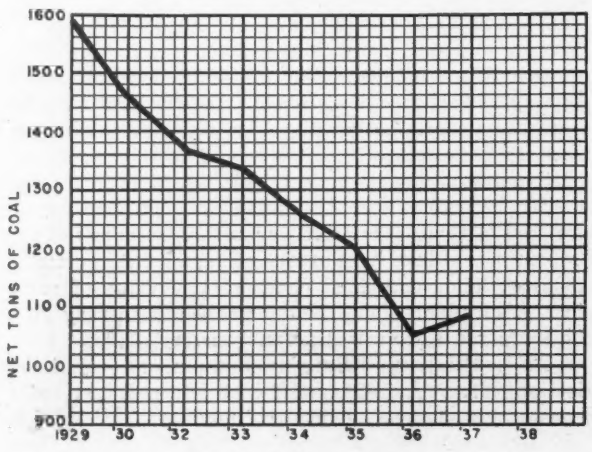


Fig. 2. Coal record curve

Modern heating systems can be balanced so that all parts will heat equally at a great saving in fuel and in wear and tear on the human elements involved, even if not on the system itself. The reduction in the seasons fuel bill after a system has been balanced is something for the plant owner who pays the fuel bill to be elated over. An experience is given here of what has been accomplished at the heating plant of the Howland Dry Goods Co., at Bridgeport, Conn., from 1929 to 1936.

New System Installed

During the summer of 1928 when the construction of a new addition to the store increased the floor space about 50 per cent, it was decided to remove the old heating system from the old section of the buildings and install a entirely new heating system throughout the store proper. This heating system was designed by Warren Webster and installed by a local steam heating contractor. From Jan. 1 to Dec. 31, 1929, 1590 net tons of bituminous coal were consumed of which 275 net tons were for hot water service and live steam used in the cafeteria of the store for the year. The following year a vigilant system was adopted of adjusting the modulation valves on the radiators throughout the entire plant in order to get a uniform temperature over all sections of the buildings which contained a total of 47,000 sq. ft. of radiation, of which 24,000 sq. ft. is indirect, 16,000 sq. ft. of direct, and 7000 sq. ft. of direct (gravity return) in adjoining buildings. This resulted in partly accomplishing the desired aim and naturally affected the coal consumption as the record shows. This plan was closely followed till the summer of 1932.

During the period of the business slump the engineers in their laboratories were working on new devices to help speed recovery and were successful thereby in developing a heat control to control the heat of buildings by outdoor temperature. It was claimed that this device and the installation of orifice plates in all radiators and branch lines would accomplish substantial savings. The engineering type of mind, however, will neither accept all that it hears as true, nor turn down any suggestion without investigation, so hand manipulation of radiator valves continued and in addition the same procedure was applied to the valves on branch

supply mains by partly closing them off in order to try to produce a balanced system. If this scheme works it was argued, the complete orificed installation with automatic heat control will work as predicted by the designers. So from Oct., 1932, until May, 1934, this experiment was tried and in spite of the fact the winter of 1933-34 was the coldest in this part of the country in many years, the coal consumption continued a downward trend as the record chart will bear testimony.

Heat Control System

The results left no further doubt. During the summer of 1934 the system was modernized by the installation of orifice plates in all radiators and in each of the sectional supply mains. A heat control to maintain the indoor temperature by outdoor temperature was installed at the same time. The initial cost, in addition to the added cost of pipe changes and electric wiring, was amortized in a two year period.

A brief description of the heat control that is actuated by outdoor temperature may be helpful to those not familiar with this modern device. A thermostat "the brain of the control" weighing about 50 lb. is set on the upper part of the building, a pent house, or other structure projecting above the level of the roof facing towards the north, if possible, and protected from the sun rays by the shade of the supporting part of the building. This contains a bimetallic coil the center of which is connected to a movable arm, the outer part of coil being secured to the frame. The lower end of the arm has a roller contact that moves over semi-circle contacts submerged in oil. These contacts are connected to a multi-wire cable that connects with control panel which may be termed "the nerves of the control." This panel is located in or near the boiler plant, wires connect the control panel and a motor operated valve of the semi-balanced piston type, with V-ports that is "the heart of the control." Any variation in outdoor temperature is transmitted to the control valve to increase or decrease the quantity of steam to the system

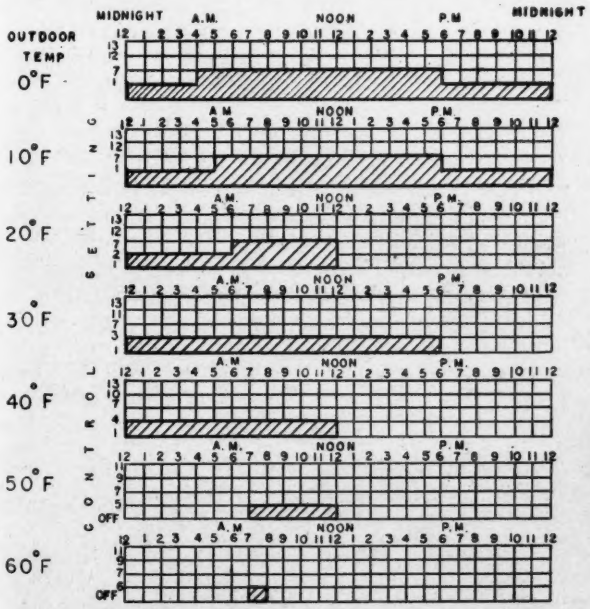


Fig. 3. Operating schedules for heat control

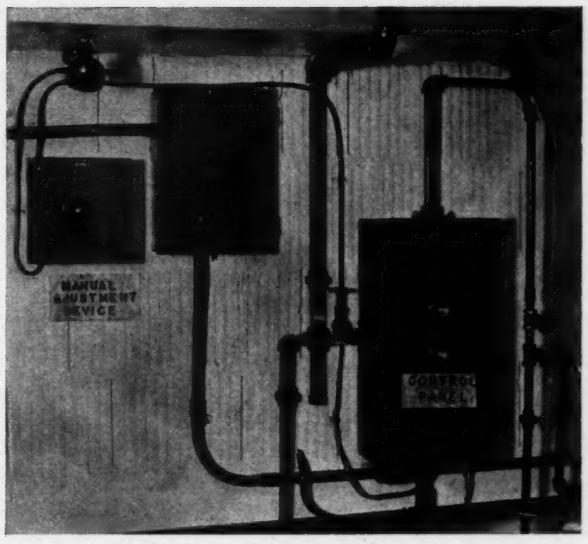


Fig. 4. Heat control units

as the weather demands. A manual adjustment device with an adjustable knob and a numbered dial is mounted near, and wired to the control panel, or may be located anywhere in the building to compensate for wind velocity conditions and quantity of steam supplied to the system during night and Sunday hours, which is 50 per cent of normal. A schedule is followed as (shown in cut) according to outdoor temperature to maintain the indoor temperature desired.

Designers of modern heating systems have used science and mathematics against nature, so that the systems they design and install today make possible uniform heat, plus the extracting of more dollars from the heating plant coal pile than was possible a few years ago.

Coal Record

	net ton used	% Yearly saving over previous year	Annual saving in net ton
1929	1590	....	....
1930	1459	8.24	131
1931	1369	6.17	231
1932	1340	2.10	250
1933	1260	5.97	330
1934	1201	4.68	389
1935	1055	12.15	535
1936	1088	3.06 increase	502
		Total....	2368

The increase in 1936 was due to change of schedule of operation and the addition of 500 sq. ft. of radiation.

The average cost of fuel was $5.83 per net ton for the 7-yr. period.

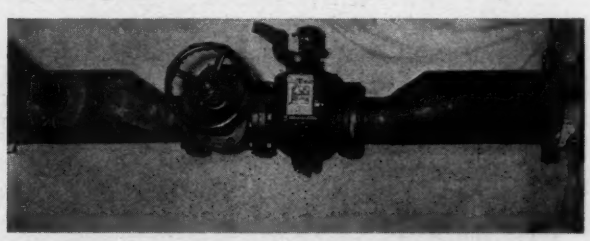


Fig. 5. Motor operated valve—the heart of the control

Contributions to Power Development

Significant Contributions to Industry Through Work of Johns Hopkins University

DURING the celebration of the twenty-fifth anniversary of the School of Engineering at Johns Hopkins University one of the most interesting papers presented was contributed by Professor A. G. Christie and deal with Progress in Power Development, appropriate to the occasion, it was a review of the past 25 yr., starting with a general description of the average power plant of 1912 and traced industrial progress, as it followed research, through the years to the outstanding features and accomplishments of the present day, highly efficient power plant.

To readers of Power Plant Engineering, this history, though extremely interesting, is well known and needs no repetition at this time. The part played by Johns Hopkins University, however, which was given in the concluding paragraphs of Professor Christie's paper, is highly enlightening, as it is direct evidence of what one live educational institution has done in the way of research alone that has contributed not only to the welfare of the power industry but to the conservation of our national resources. This interesting recital of accomplishments is given in the following paragraphs.

Professor C. C. Thomas invented and tested a spray nozzle for water cooling about 1916, and these developments led to a wider use of spray ponds. He later studied separators to remove moisture from steam and is still working on this problem.

About 1916 Professor Smallwood started some of the studies on chimneys which led to the modification of some of the earlier conceptions of chimney performance. This work was followed by similar studies elsewhere, which developed certain problems of flow over rough surfaces. Dwyer, '33, and later Weitzel, '32, have studied such flow in our laboratories and have secured data upon which a correct interpretation of chimney performance is now in process of development.

During the war, the University was not on the preferred list for coal and anthracite dust was burned for a time upon underfeed stokers. Tests were run at our plant on this method of burning anthracite preliminary to the design of Holtwood station, but pulverized fuel offered better possibilities.

Stansbury, '21, and Weil, '21, made some studies of losses in small steam turbine generators which directed attention to the economic performance of such units in central stations.

Lieut.-Com. Linsley, '22, investigated the critical bearing pressures causing rupture in lubricating oil films. He showed that greater unit pressures could be carried than in earlier practice.

Turnbull, '24, studied the possibilities of higher steam pressures versus higher steam temperatures and in 1925 presented a paper before the N. E. L. A. on this subject. This paper created widespread interest and caused one of the largest foreign builders to alter its whole line of steam turbine development.

Franck, '26, analyzed the effects of reheating by several systems on station economy. His study, published by N. E. L. A. in 1928, demonstrated the limitations of steam reheating as compared with flue gas reheating. This information has influenced plant design since that time. Franck's later work on "Condition Curves and Reheat Factors" won for him the A. S. M. E. Junior Prize and also increased available knowledge of turbine design factors.

About the time that the Ruth's accumulator was under consideration for power plants, Viessman, '22, studied the possibilities of hot feedwater storage for peak load service and concluded, in a paper presented in 1931 before A. S. M. E., that this offered one of the cheapest means for carrying peak demands. So far, this system has not been applied in full in this country, although it is used in Germany. Viessman also studied the economic division of heating surface between boiler proper, superheater, economizer and air preheater. This early study foreshadowed the problems involved in recent boiler designs.

Colburn, '32, made a special study of the low pressure blading steam turbines. After his conclusions were published by N. E. L. A. greater attention was given to the design of low pressure blading and to the leaving losses. Colburn concluded that the blades in the last row of all turbines should be given a degree of reaction and this has become standard design practice.

Professor C. A. Robb investigated recompression effects in steam nozzles in 1932. He found certain peculiarities in the expansion curves that did not appear to have been observed by earlier experimenters and which were puzzling to explain from the data at hand. Yellott, '31, believed that these might be due to supersaturation effects. Up to this time, supersaturation and its effects in steam turbines had been much discussed theoretically, but had never been completely demonstrated by experimental methods. Yellott, in an A. S. M. E. paper in 1933, not only demonstrated the existence of supersaturation by a clever optical method, but showed its quantitative amounts. This study later won for him the Junior Prize of the A. S. M. E. Later Rettaliata, '32, in an A. S. M. E. paper in 1936, studied this undercooling in commercial nozzles and determined the effect of roughness of approach conditions and of Prandl's recompression in actual nozzles. These studies indicated methods of improving nozzle design in the wet regions of turbines.

Lieut. Dennison, '35, carried out an extensive study of the fatigue strength and flexibility of corrugated and creased bend piping now widely used in power plant work. He found that these forms had much greater flexibility than standard piping, but that their fatigue strength was lessened in about the same ratio as the flexibility was increased.

Canfield, '23, inaugurated work in the metallographic laboratory and started the study of metals at the University. Many metallographic investigations have since been made for various power plants and instruction in this science has been extended to undergraduate students.

Further Considerations Underlying Furnace and Heat Trap Design*

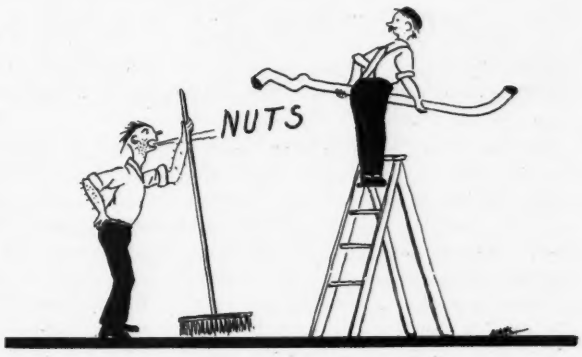
BY PULVERIZER PETE

YOU MAKES ME most happy, Editor, by writing me as to how much you likes the article I sends you. I am glad you recognizes that you has discovered a genius and that it makes you feel like a Barrymore uncovering a new Elaine. But this is the first I hears about her doing a strip-tease act.

Last month I gets a lot of remarks which sounds like wisecracks from guys what wants I should preheat my secondary air. Nuts, I says, for where does you get the heat to make it hot? From an air heater which gets hot from the furnace. So I leaves so much heat in the furnace, because why take it out and blow it right back?

Now we got to build the boiler. Maybe it's best you should pick a straight tube one because I ain't so hot on the bent ones. First you gets a drum—any old gasoline barrel or tank car is ok. Then you connects a lot of pipes from the drum to the furnace tubes. The ones which water comes down in, you hope, is downcomers, and those which takes steam up, unless it gets stuck and blows up the tube is sometimes called risers, but I calls them upgoers. Now, you has probably figured your tube sizes all cock-eyed so you connects the drum and the furnace tubes with a couple of ten or fifteen inch pipes which some says is make-ups but really means "make-sures."

*Continued from last month.

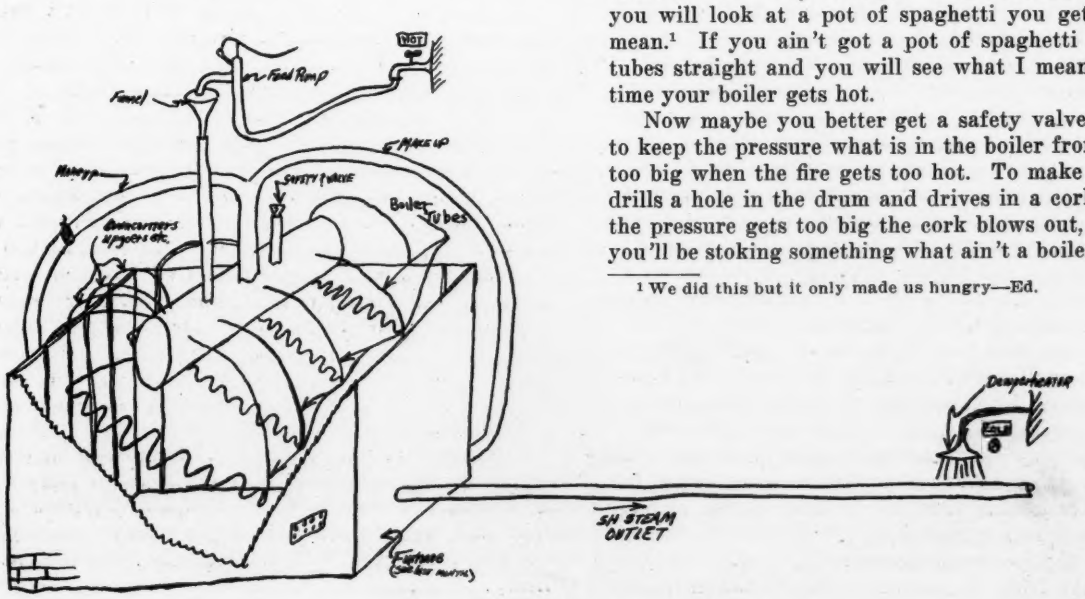


Nuts, I says, For where do you get the Heat to make it hot

For the boiler itself all you got to do is run a flock of tubes down from the drum uphill across the furnace and back up into the drum. The picture shows what this should look like to date, plus a few attachments which I tells you about later. When the boiler works, water comes down to the deep ends and when it goes up across the furnace turns to steam and goes up the upgoers. Now you has probably seen a road which winds up a hill to make it easier for a lizzie, so I bends the tubes the same way to make it easier for the steam. If you will look at a pot of spaghetti you gets what I mean.[1] If you ain't got a pot of spaghetti leave the tubes straight and you will see what I mean the first time your boiler gets hot.

Now maybe you better get a safety valve which is to keep the pressure what is in the boiler from getting too big when the fire gets too hot. To make such you drills a hole in the drum and drives in a cork. When the pressure gets too big the cork blows out, or else—you'll be stoking something what ain't a boiler.

[1] We did this but it only made us hungry—Ed.



Also you should get a funnel for your make-up, or fill-up water, because when you puts your steam through the turbine or condenser you will find something is missing when it gets back and a funnel will keep you from splashing it when you pump in the make-up, which is to say a feed pump is also necessary.

Probably you is wondering about superheaters and economizers which I ain't forgotten, but you can forget the economizers because all you got to do is get your make-up water from the tap marked "hot." About the superheater I will let you into a trade secret. You will remember I tells you to put a lot of tubes in your furnace and unless you is unusual good at boiler building your fire is going to smack these tubes someplace—and that's where you connects your superheated steam pipe. Of course if you wants to be conventional you can connect a pipe with a marcel wave in it to the drum and put it in the furnace to superheat the steam, but don't blame me if you gets a lot of hot water like some guys I know.

To be up to date you gotta have superheat control. That is easy—just run your pipe under a handy shower; when the steam gets too hot, turn on the cold shower.

Now digest this, Editor, and next month we gets to the important fazes like turbines, reheat boilers and maybe a little theory.

Paying the Piper

Lack of Attention to a $35 Oil Separator Caused a $600 a Year Fuel Loss But a $600 Investment and a Little Ingenuity Saved $1900 Annually

By ZUCE KOGAN
Consulting Engineer
Chicago, Ill.

NEGLECT of one small item in a chain of equipment may well lead to complications and waste. If the effect is small this wasteful method of operation may continue for a long time. In the following paragraphs a case is described where the neglect of a small oil separator led to large waste of steam:

The owners of a woodworking plant called us in some time ago to look over their plant, with the object of determining how their operation could be improved without making extensive changes. This plant had two 150 hp. h.r.t. boilers equipped with underfeed stokers and with provisions for burning wood shavings. The plant generated all of its power and had a small outside line coming from the local utility to provide a small amount of light for the plant. Power was generated by two engine generator sets, and the exhaust was utilized in the dry kilns in the summer and for the dry kilns and heating the building in the winter, supplemented whenever necessary, with live steam. Condensate from the heating system and the dry kilns was returned by a steam driven vacuum pump, to the feedwater system.

Exhaust from the vacuum and feedwater pumps was wasted into the atmosphere and it was this waste of exhaust steam, in a place where exhaust steam was highly needed, that was most conspicuous and a short talk with the engineer made it clear to us how this was brought about. Many years previously when the plant was installed, the exhaust header from the engines was equipped with one large oil separator and the exhaust header from the vacuum and feed pumps, was equipped with a separate oil separator. The exhaust from the feed pumps was fed into a closed feedwater heater and surplus available in the summer time was by-passed to the atmosphere. The reason for this separation was the desire to operate the generating engines at low back pressure, which was sufficient for the dry kilns. The exhaust pressure of the pumps was higher in order to obtain a high feedwater temperature.

In time, the oil separator on the exhaust header of the pumps stopped separating, the feed water heater tubes were covered with a heavy film of oil and the engineer found it expedient to waste the exhaust steam into the atmosphere. Tests indicated 5 to 8 per cent of the total steam used during the day time, was wasted, and at night when the load was considerably reduced, the loss was proportionately greater. Obviously the thing to do was to connect the exhaust header from the pumps to the main exhaust header. or, install a new separator and bring it back to the original condition. Further study however showed another solution to be more advisable for this particular plant.

First the generation of power was stopped at 6 p. m. and the boilers operated at night at low pressure. The engineer no longer tied to the plant, as required by the city ordinances for high pressure operation, and the engineer willingly assumed the watch service.

Inasmuch as the dry kilns were quite a distance away from the boiler room and return line below the level of the boiler water, some means had to be employed to return this water. An electric pump could not be used because the incoming line from the utility was barely large enough to supply the necessary lighting. The use of a return trap was recommended and, as this return trap could also operate at high pressure, the necessity of the vacuum and feedwater pumps was thereby eliminated for day time operation as well. Elimination of the pumps, which under these circumstances were wasteful, brought about some saving in the night operation and eliminated the outside watch service.

At night the dampers were set so that the steam pressure could not rise above 10 lb. the limit for low pressure according to the city ordinances. The annual saving resulting from this installation was in the neighborhood of $1900.00 about $600.00 saving in fuel and $1300.00 per year in watch service. This saving necessitated an initial investment of $600.00.

"THE ONLY sources of prosperity are the productive enterprises of our country through which all the people coöperate to create wealth in the form of goods and services. When the public is convinced that it should look there rather than to government, employment and prosperity will be attainable."—John W. O'Leary.

What's a Million Pounds to Ford?

New 110,000 turbine unit and new boiler ordered April 12. Record output of over 1,000,000 lb. per hr. set by boiler unit installed last year.

WORLD'S RECORDS in the world's largest high pressure power plant may engender only ennui in the Ford Motor Co. personnel but these records are news to the rest of the world. The latest is 1,040,000 lb. per hr. of steam from the 1250 lb., 900 deg. F. boiler placed in service last July.

Don't say a million pounds is not a new record, for although New York can boast a steam output in excess of this, that record was made on a lower pressure, the new record from the Rouge plant is for high pressure, high temperature operation and it will probably stand until the new Logan boiler gets under way next year. Logan was designed for about 10 per cent greater output than the Ford boiler.

The record making boiler is of the five drum bent tube type, 115 ft. high and with a floor area of 25 ft. 8 in. by 32 ft. sq. It contains 39,500 sq. ft. of heating surface, 22,000 sq. ft. of superheater surface, 25,300 sq. ft. of economizer and 86,016 sq. ft. of air heater surface. The weight is in excess of 3,600,000 lb. per hr.

Steam produced is used in a 110,000 kw., vertical compound turbo-generator, the second unit of that

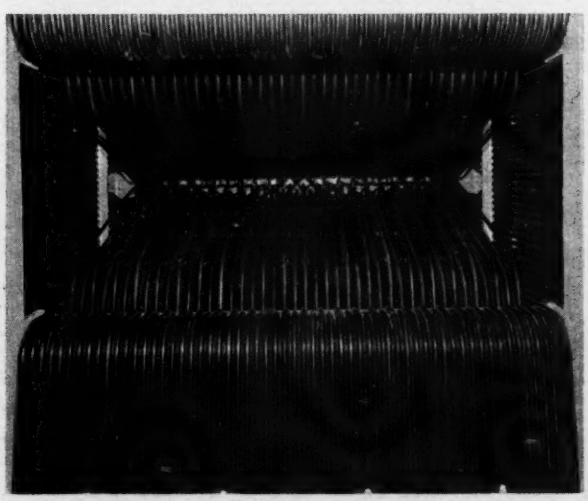


Fig. 1. The new Ford boiler is fired by pulverized coal at a maximum rate of about 45 t. per hr. This photograph was taken from the bottom of the furnace looking directly upward. The superheater elements are visible between the boiler tubes.

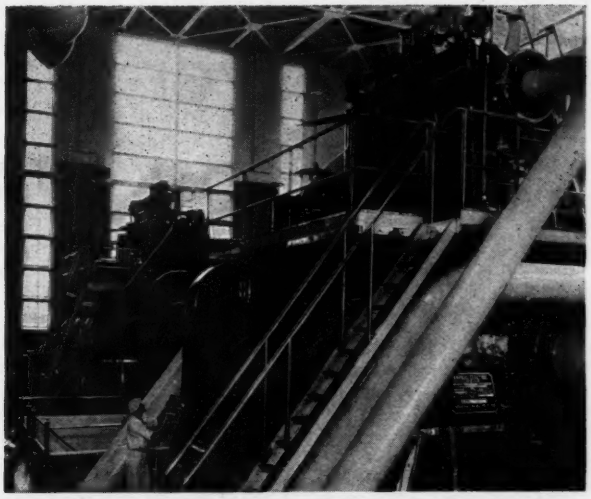


Fig. 2. Two 110,000 kw. turbo generators in the River Rouge plant. The new turbine is in the foreground. A new unit of the same size has just been ordered.

type installed in the Rouge plant, both the largest of their type yet built. The first unit utilizes a steam reheater, but the 900 deg. F. steam from the new boiler made it possible to eliminate the reheat feature from the second turbine.

Power Consumption

Electric power consumption of the Ford Motor Co. for 1936 set an all time peak of 724,567,451 kw-hr., more than 22,000,000 kw-hr. over the 1929 record. The increase is attributed to increased production, beginning of operation of the new Ford steel mill and reopening of the modernized Rouge Glass factory. The bulk of this power was supplied from the Rouge power houses although 987,300 kw-hr. were purchased and 194,400 kw-hr. were produced from the Ford Co. hydroelectric plant on the Huron River at Flat Rock, Mich. Fuel used amounted to 747,319 t. of coal, 53,050,938 gal. of fuel oil, coke breeze equivalent to 43,245 t. of coal, and 43,139,300,000 cu. ft. of blast furnace and coke oven gas.

New Order Placed

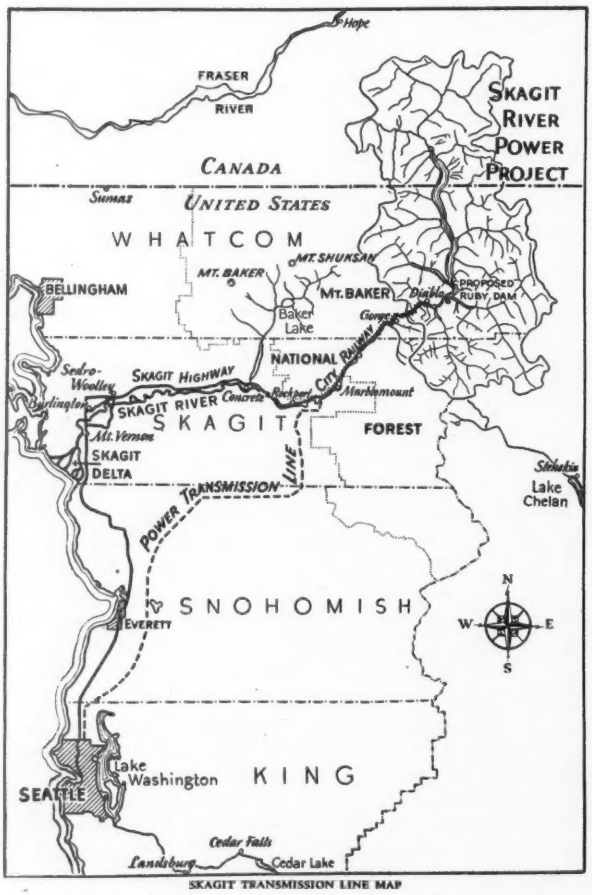
Following Mr. Ford's return from the south the middle of April an order said to total $5,000,000 was placed with the General Electric Co. for another 110,000 kw. turbo-generator. On the same day an order was placed with Combustion Engineering Co. for a 900,000 lb. per hr. boiler, both the boiler and turbine apparently being duplicates of the 1250 lb., 900 deg. F. units mentioned in the paragraphs above and put in service for the first time last summer.

When these units are completed the high pressure section of the River Rouge plant will have a rated output of 3,300,000 lb. per hr. of steam from four boilers and 345,000 kw. in four turbines the additional 15,000 kw. being a non-condensing unit supplying 250 lb. process steam. Apparently this latest increase in Ford's Rouge Plant is part of the program referred to in a recent statement that his company would "demonstrate some real competition in quantity production with new methods that will call for more skill, higher wages and a larger number of employees."

Skagit River Development to Cost Only $90 per Kw.

ASIDE FROM the large government hydroelectric projects on the Columbia River, the most important water power development in the Pacific-Northwest, is that belonging to the City of Seattle, on the Skagit River. This project has been in the making some 13 yr., beginning with what is known as the Gorge Plant in 1924. This was the first of three units of a million horsepower project going into operation in September, 1924, with two generators. A third generating unit was added later so that now the Gorge Plant has a generating capacity of 55,000 kw.

The second part of this development is seven miles upstream from the Gorge Plant. This consists of the Diablo Dam and Diablo power house with an installed generating capacity of 133,300 kw. Construction of the Diablo Development was begun in October, 1927, and the Dam was completed in 1930; the generating units, however, were not installed until early this year.



SKAGIT TRANSMISSION LINE MAP

Fig. 1. The Skagit River Development and its location with reference to Seattle

Diablo Dam is a concrete dam measuring 389 ft. in height, 1180 ft. along the crest, 146 ft. at the base, and contains 350,000 cu. ft. of concrete. Water from the lake above the dam is delivered to the turbines through a tunnel 19.5 ft. in diameter, driven through solid rock for 2000 ft. At its lower end this tunnel connects into two 15 ft. penstocks leading to the power house.

Now, the third unit in the development is about to be started. This is to be known as the Ruby Dam Plant and, in the development of the Skagit, is the key to the entire project. The reservoir which will be created by this dam is necessary to equalize the flow of the river and conserve flood waters until they are needed for power. Without Ruby Dam, the output of the Skagit is limited to the natural flow of the river, and in extremely dry seasons the Gorge and Diablo installations will have more capacity than the flow will carry. With Ruby Dam each of these plants may be increased to 320,000 hp. and 480,000 hp. may be installed at Ruby. When this part of the development is completed each of the other plants can be extended to about twice their present capacity. Consequently the ultimate total capacity of the entire development will be 1,120,000 hp. with an annual output of about 2,600,000,000 kw-hr. The entire project will produce the ultimate 1,120,000 hp. at a cost of only $67 per horsepower or $90 per kw., which it is claimed is lower than the cost of any large project yet built or proposed. Including the 220,000 v. transmission lines to Seattle, the cost of the entire development will be only $76 per horsepower. This will be the cheapest unit cost of any large hydroelectric development in America.

Ruby Dam will be 635 ft. high, second only to Boulder Dam. It will be 1600 ft. along the roadway across the top and will contain 2,250,000 cu. yd. of concrete.

The design of the dam has been practically completed and it is expected that bids will be requested in a few weeks. It will be of the straight gravity type, 580 ft. thick at the bottom, grading to 42 ft. at the crest. This dam will produce a head of 510 ft. for Ruby power house which will be located just downstream. The dam will create a reservoir 35 mi. long with more than 3,000,000 acre feet storage, or about 600 days run off of the stream. It will thus give complete control of the Skagit for power purposes, regulating not only the future Ruby Plant but also for Diablo plant, now containing 133,300 kw. of generating capacity, ultimately to contain 240,000 kw., and for Gorge plant now containing 55,000 kw. ultimately to contain 240,000 kw.

The first step of the dam to be finished by June, 1938, is estimated at $4,500,000 and will raise the water approximately 190 ft. It will include full base and upstream portion of the ultimate dam to partial height.

Completion of the ultimate dam will depend upon the power demand which it is estimated will require the dam to be finished in approximately ten years.

Ultimately, it is planned to raise the crest of Ruby Dam at least fifteen feet higher than is required for power purposes, and to use the additional storage capacity to control flood waters for protection of the valley below. This will bring the crest to an elevation

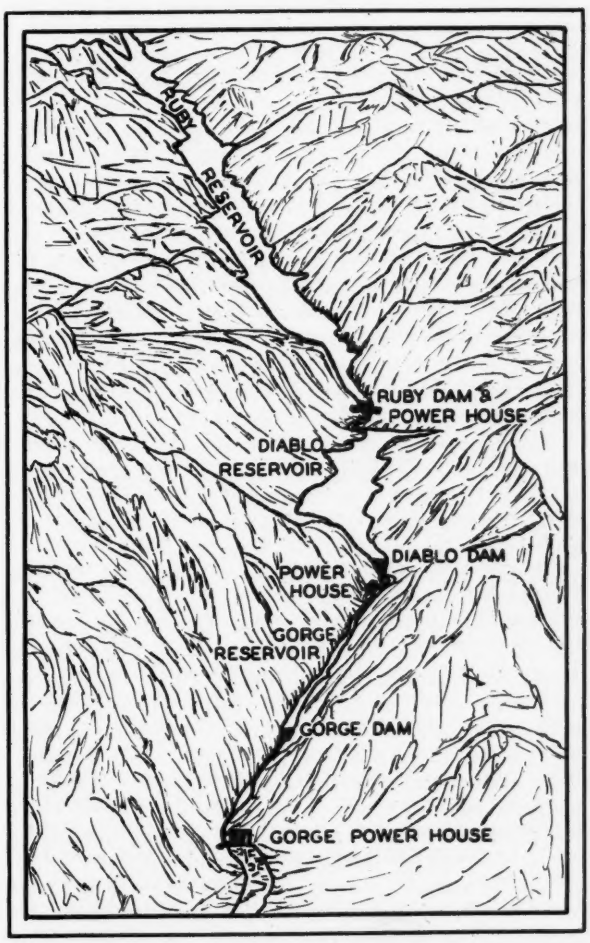


Fig. 2. Showing the relation between Gorge, Diablo and Ruby Dams in the Skagit River Development

of 1725 ft. above sea level, with the spillway at elevation 1710. The area of the reservoir at the top will be approximately 20,000 acres, or 31.25 sq. mi. The highest flood ever to be expected would raise the level only 6 ft. in one day so that Ruby Dam will give complete control of flood waters at that point in the river.

It will require approximately 2 yr. to clear the Ruby basin, which contains about 20,000 acres with a great deal of second growth and small trees, with several thousand acres, largely in the upper valley, of heavy timber. The reservoir can be raised to elevation 1475, to give a lake 11 mi. long with very little heavy clearing. Such a lake will give enough storage for the first Gorge and Diablo plants, and also make logging operations on the higher levels much easier.

The Ruby Plant will involve the construction of two tunnels approximately 600 ft. long and 24 ft. in diameter, through granite around the end of the dam. Four 100,000 kv-a. transformer banks will step the voltage up to 220,000 for transmission to Seattle over two double circuit transmission lines on steel towers. These lines will have a capacity of 180,000 kv-a. per circuit, the conductors to be of 795,000 c.m. aluminum cable, steel reinforced.

21 Per Cent of Nation's Water Power Developed

THE TOTAL capacity of water-wheels at water-power plants in the United States on January 1, 1937, according to the annual report just released by the Department of the Interior through the Geological Survey, was 17,119,610 hp., an increase of 1,040,203 hp. during 1936, the largest since 1930 when it increased 1,076,889 hp.

The following table shows the total capacity of water-wheels in water-power plants in the United States at different dates and the increase between dates:

Date	Horsepower	Increase Horsepower	Increase Percent
1921 (November)	7,927,958		
1924 (March)	9,086,958	a/1,160,000	14.6
1925 (March)	10,037,655	958,697	10.5
1926 (January 1)	11,176,596	b/1,138,941	11.3
1927 do.	11,720,983	544,387	4.9
1928 do.	12,296,000	575,017	4.9
1929 do.	13,571,530	1,275,530	10.4
1930 do.	13,807,778	236,248	1.7
1931 do.	14,884,667	1,076,889	7.2
1932 do.	15,562,805	680,930	4.3
1933 do.	15,817,941	255,136	1.6
1934 do.	15,913,451	95,510	.6
1935 do.	16,075,307	161,856	1.0
1936 do.	16,079,407	4,100	0
1937 do.	17,119,610	1,040,203	6.5

a/ About 2.3 years. b/ About 0.8 year.

An estimate based on the present practice of installation of water-wheels at fully developed water-power sites indicates that water-wheels with a capacity of about 80,000,000 hp. would be required to make use of all the potential water-power in the United States. Therefore 21 percent of the Nation's resources of water-power is developed at the present time.

The complete report shows the total capacity of water-wheels in plants of 100 hp. or more, by States and main divisions of the United States, segregated between public-utility companies and manufacturing companies; the trend in development in different sections of the country; and the rank of the ten leading States in developed water-power from 1924 to 1937. Copies of the complete report of four pages may be obtained on application to the Director, United States Geological Survey, Washington, D. C.

GENERAL ELECTRIC CO. reports that orders received for the first quarter of 1937 amounted to $105,747,030, compared with $59,569,879 for the corresponding quarter of 1936, an increase of 78 per cent. This was the largest first quarter in the history of the Company.

A.S.T.M. Committee Week

VARIOUS committees of the A.S.T.M. meeting at the Palmer House in Chicago, March 1 to 4 approved a number of new specifications and tests which will be submitted to the society at the annual meeting in June. During the same week the Regional meeting on March 2 and 3 consisted of two symposiums, one on corrosion, the other on lubrication. Dr. F. N. Speller, of the National Tube Co., headed the committee which developed the papers in the corrosion testing symposium, and H. C. Mougey, of the General Motors Corp., was chairman of the committee in charge of the lubricants symposium.

Corrosion and Lubrication

C. W. Borgmann and R. B. Mears in their paper on "Principles of Corrosion Testing," classified the various types of tests into three broad groups: laboratory, field, and service. After a brief review of the theory of corrosion (the authors adhered to the electrochemical theory) they discussed the various methods of estimating the rate and extent of corrosion.

In conclusion, they listed certain tests on which in their opinion sufficient data are available to justify standardization. These were divided into, first, laboratory tests such as impingement attack, inter-crystalline corrosion, corrosion-fatigue, partial immersion and spray tests, and second, field tests, such as atmospheric exposure, soil corrosion and immersion. Laboratory tests which seem to require further work before standardization, included stress corrosion, film breakdown tests, crevice, total and alternate immersion, and dezincification of brass.

In their paper on Engine Deposits, Causes and Effects, W. A. Gruse and C. J. Livingstone, Mellon Institute of Industrial Research, discussed five general locations where collection of foreign material in engines may be expected, namely, combustion chamber, valves, under piston surfaces, piston rings and crankcase. In considering combustion chamber deposits, the authors indicated that while carbon deposition does not seem to constitute a bottle neck in further engine progress the reduction of such deposits by all means available will be of real assistance.

They pointed out that there apparently was no common cause for or one type of ring fouling failure for all classes of engines. It appears that there is a type of ring clogging attributable to low-temperature duty and another arising in high temperatures. The latter is complicated by differences in oils and in engines and the problem remains a puzzling one. In concluding it was indicated that "if the engine designers can be encouraged to recognize the inherent limitations of organic compounds—lubricating oils and fuels—and at the same time the operators can be persuaded to stay within the limits for which their equipment was built, and if further, wise selection of fuels and lubricants is made, then the happy days of failure-less operation will be close at hand."

Improving on Nature

Messrs. G. M. Maverick and R. G. Sloane, Standard Oil Co. (N. J.), in their paper on Addition Agents for Motor Oils, traced developments as indicated by patents and outlined the purpose and commercial success of the agents and at the same time warned of complications which may be involved in their use. It was pointed out that the oil industry has improved the quality of lubricants to perhaps as great an extent as it has improved fuel. This has been achieved largely as an outcome of improvements in refining methods, but the best that can be expected from refining methods is limited by the nature of the oil itself.

Oiliness agents, viscosity and viscosity index improvers, poor inhibitors, and oxidation and corrosion inhibitors have been used in hundreds of thousands of barrels of lubricating oils of the highest quality. They indicated that the crankcase oil of the future should be made with the same precision and understanding that metallic alloys are made today and that lubricants can be made more economically and also of higher quality by the use of petroleum bases carefully refined to assure cleanliness and freedom from impurities and protected by the addition of necessary modifiers.

Committee A-1 on Steel discussed a number of new, and changes on existing, standards. Included in the existing tentative specifications which were recommended at the meeting for adoption as official standards are those covering the following materials: Forged or Rolled Steel Pipe Flanges for General Service (A 181), Seamless Cold-Drawn Heat-Exchanger and Condenser Tubes, and Still Tubes for Refinery Service (A 179) and (A 161) and Electric Resistance-Welded Steel and Open-Hearth Iron Boiler Tubes (A 178).

Several new specifications have been in course of development during the past year. Products covered by some of these new specifications include intermediate alloy seamless still tubes and intermediate alloy seamless heat-exchanger and condenser tubes. These are proposed as companion specifications to existing A.S.T.M. items for similar carbon and alloy steel products. The committee on boiler steels reported progress on a very active program which includes four new specifications covering carbon steel, low carbon nickel steel, molybdenum steel, and chromium-manganese alloy steel plates of flange quality for locomotive boiler shells and of flange and firebox qualities for stationary boilers and other pressure vessels.

B. W. G. on the Way Out

An interesting development in the work of the subcommittee on steel tubing and pipe is the proposal to eliminate the use of Birmingham wire gage in the tube specifications and the substitution therefor of a system of designating the wall thickness by decimals of an inch. A special subcommittee was appointed to develop recommendations at the June meeting concerning this matter and also the question of coordinating wall thickness tolerances in accordance with the change in method of designation. The committee has under preparation a new specification for alloy-steel boiler and superheater tubes for high-pressure and high-temperature steam service.

The existing standard specifications A 158 cover-

ing seamless alloy-steel pipe for high-temperature service are to be redrafted as a new tentative specification. Because of the wide usage of the carbon-molybdenum alloy steel composition, especially by the power industry, in ranges of 900 to 1000 deg. F., this grade will be removed from the specification and covered in a proposed new tentative standard. In the revised specifications A 158, three alloys are to be deleted because of the lack of demand and five new alloys are to be added.

Specifications for condenser tubes and ferrule stock cover seamless tubes and ferrule stock of various alloys for use in surface condensers, evaporators and heat exchangers. The chemical composition requirements provide for various types of alloys including Muntz metal, admiralty, red brass, aluminum brass and aluminum bronze, 70—30 and 80—20 copper nickel, copper, and arsenical copper. The tests require microscopical examination with a uniform grain size not in excess of 0.045 mm. in average diameter. Other tests provided include: expanding, strain and hydrostatic tests. Under the latter, each tube is to stand 1000 lb. per sq. in. without leakage. When approved as tentative it is anticipated that this new specification will be a consolidation and replace other existing standards covering specific materials.

RESEARCH

The A.S.T.M. Research Committee on Fatigue of Metals outlined a number of problems including the following: Strength developed in specimens when tested in different ways, such as direct repeated pull, repeated bending, repeated twisting, differences between results with solid and hollow specimens; the effect of lubricant in changing the strength of parts subjected to repeated pressure over a small area, such as gear teeth, ball bearings, and car wheels; the behavior of different metals when subjected to loads above the smallest value which will cause eventual failure, that is the length of life which can be expected for such loads and the lowered resistance to subsequent repetition of lower loads; the effect of cold working and heat treatment on the crystalline structure of metals and the resultant effect on resistance to repeated stress and the damage done by occasional overstress; and the effect of speed of repetition of load on the resistance to repeated stress.

Electron Tubes

(Continued from page 287)

photoglow tube, of course, is a special form of gas filled tube.

The high vacuum type of phototube is amazingly sensitive in its response and is capable of measuring the most minute and rapid variations in light intensity. There are other photoelectric cells available, which behave similarly, but none of these have the rapidity of action of the vacuum phototube. It is for that reason that the phototube finds application in television systems, for in such work speed of response is paramount.

Phototube circuits always have a battery or other source of potential in the circuit. In general there will be a small current to the anode even if no accelerating potential is applied to the anode, provided the frequency of the incident light is high enough, but this current is so small as to be negligible. The higher the voltage of the battery, the greater will be the photoelectric current up to the point where the voltage on the anode is high enough to attract all of the electrons emerging from the cathode surface. This is called the saturation current of the tube and corresponds exactly to the saturation current in the diode.

After 30 Yr. Turbines Creep

MODERN STEAM TURBINES operate at such high temperatures and under such high pressures that designing engineers must guard against the stretch of steel used in their construction. Turbine materials are tested for years at a time by manufacturers and changes of one part in a million are recorded and studied, according to E. L. Robinson of the General Electric turbine engineering department.

Steam power plants in the United States burn about the same amount of coal now that they burned in 1920, but they generate twice as much electricity with it. Part of the increase in efficiency has resulted from the use of higher-temperature steam, with a resulting higher operating temperature for all parts of the turbine. A modern turbine shell runs, almost literally, red hot.

The rotor is an immense top, often weighing as much as 20 t. It spins at whirlwind speed inside a shell which has to withstand pressures such as exist ½ mi. down in the ocean. But the top spins true, and the shell does not leak, in spite of the pressure and the heat. Heat softens metal, just as it softens molasses candy; just as candy stretches when it is pulled, so does the steel, so care must be exercised to keep the stretch of the steel to the merest creep.

In the Schenectady turbine factory are automatic electric furnaces, held at temperatures which occur in turbines. In them, rods of turbine materials, under constant tension, are tested for years at a time. A turbine may change size as time goes on, provided such changes are symmetrical and uniform, but the changes must not exceed about one part in a thousand. The measuring gauges on these furnaces easily indicate changes in rod length of one part in a million. We are able to watch, from week to week, the creep of these heated and stressed rods and to determine what stresses may be used without excessive distortion.

The mechanism of creep is not well understood. In a high-speed machine, an hourly change in length of one part in 100,000,000 is not unreasonable, and our test equipment can detect such movements in a week's time. Yet our scientists tell us that the spacing between atoms of iron measures approximately 1/100,000,000 inch. Perhaps the imposed stress gradually pries an atom loose from its neighbor so it can grasp the next atom beyond. If this divorce and remarriage occur as often as once per hour per inch of length, the material maintains its continuity and strength. But, if they get to happening oftener than once a second, the material is unsuitable to withstand the temperatures and pressures in turbines.

Creep testing allows us to weed out undesirable materials and incorporate in turbines only steels which will maintain their shapes and dimensions within allowable limits during the lifetime of the turbine.

Delray No. 3

Three new 75,000 kw. units will increase station capacity to 375,000 kw. and make it the largest on the Detroit Edison Co. system

LOAD INCREASES in the metropolitan district of Detroit has been so promising that The Detroit Edison Co. recently authorized a new extension to Delray No. 3. This extension will house three 75,000 kw. turbines and six boiler units. A seventh new boiler, to be erected in the older section, in space now occupied by the 1000 deg. F. experimental superheater, will serve as a spare to both the old and new sections.

Steam conditions of 815 lb. and 900 deg. F. will be the highest on the company system. Trenton Channel and the present Delray No. 3 both operate at 375 lb., 700 deg. F., Maryville at 275 lb., 700 deg. F. and the new Connors Creek unit at 600 lb., 825 deg. F. Both Trenton Channel and Marysville are fully completed, Connors Creek modernization is nearing completion and Delray is the only open-ended, or uncompleted, power plant in the system where capacity can be added without building a complete new station.

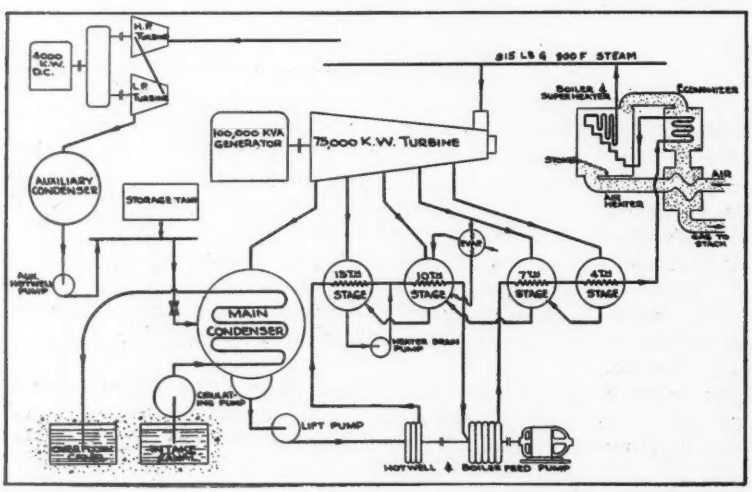
New boilers will be considerable smaller than the old ones and will be mounted at the top of a large, completely water-cooled furnace 23 by 26 ft. in floor area and about 65 ft. high. The steel columns which support the furnace and boiler will inclose a floor space 30 ft. square. Superheaters will consist of vertically-suspended loops of steel tubing with the last few loops of alloy steel to resist the high operating temperature. The amount of alloy tubing needed is much less than would have been the case with a smaller furnace as the water cooled walls will absorb a great deal of heat. Furnace gas reaching the boiler and superheater will be several hundred degrees cooler than is the case with the new Conners Creek boilers or the earlier Delray No. 3 boilers. The superheaters will be arranged so that the amount of gas passing through may be regulated to maintain a constant steam temperature, desirable as it permits operation of the turbine at maximum temperature at all times, and results in high overall turbine-room efficiency.

Temperature of the furnace gas leaving the boiler will be close to 1200 deg. F. at maximum load, but will be reduced to around 350 deg. F. in passing through an air heater and economizer on the way to the stack. In cooling from 1200 to 350 deg. the gas will heat the water fed to the boiler from 375 to 528 deg. F. and will heat the air used in burning the coal from 100 to 350 deg. F.

Stokers for the new boilers will be essentially the same as those under the present boilers. They will be single-ended, equipped with air control and will embody the mechanical refinements found necessary or advantageous during several years of experience with the present Delray stokers. The stoker, with its ash pit, will cover the entire bottom of the furnace and will be capable of burning 22 t. of coal per hr. For each boiler the forced-draft fans will deliver over 100,000 c.f.m. of air and will require 200 hp. Gas to be handled by the induced-draft fans will approach 190,000 cu. ft. m. and will require 720 hp. The induced-draft fans will be equipped with a slotted-scroll casing to separate the cinders from the gas.

The flow diagram is a simplified picture of the arrangement of the boiler as well as that of the new turbo-generator and its auxiliary equipment. The first of the three 75,000 kw. units for this plant is now being built. The turbines will operate at 1800 r.p.m. and drive 100,000 kv-a. generators. About 27 per cent of the steam which enters the turbine will be extracted at four points for use in heating the boiler feed water. Condensers will be similar in appearance to the present main condensers except that they will be somewhat smaller in diameter with about 50,000 sq. ft. of condensing surface in about 11,000, ¾ in. diam. tubes, 24 ft. long.

Improved design permits the use of one circulating-water pump where two were formerly used. This will have a 67,000 g.p.m. capacity and will require 400 hp. Condensate from the main condenser and feed water heaters will be pumped back to the boilers by a system of three pumps in two units.



Flow diagram of the new high pressure extension to Delray No. 3 station

A.S.M.E. at Detroit May 17 to 21

Program of Semi-Annual Meeting Built Around industries in Detroit Territory with Several Sessions Devoted to Power Plant Topics

DETROIT engineers, for months, have been making their plans to arrange a program of technical papers, inspection trips and entertainment for the Semi-Annual Meeting of the American Society of Mechanical Engineers which will attract engineers from all sections of the country although stress will be laid on problems of the industries that prevail in the Detroit district. The headquarters will be established in Hotel Statler with Monday, May 17, devoted principally to council and committee meetings, the technical sessions beginning Tuesday morning and continuing through to Friday, May 21, interspersed with inspection trips, sightseeing tours and social events. The dinner meeting will take place Thursday with President James H. Herron as toastmaster and Col. Willard T. Chevalier the principal speaker whose topic will be—The Influence of Mass Production Methods as Exemplified by Detroit Industry on American Life Today. At this meeting Dr. Alex Dow will be presented with honorary membership in the A.S.M.E.

In general the meetings will be run on a closed basis. Registration will be extended to non-members of the Society only on written request of a member, made in advance, and approved by officers of the Society. In the case of the three sessions held jointly with the Society of Automobile Engineers, American Welding Society and American Society of Tool Engineers, admission to the particular sessions will be granted on display of a membership card of the representative society. Members of the Engineering Institute of Canada will be extended the same privileges as A.S.M.E. members.

The general theme of the meeting will play up the contribution of the automotive industry to industry in general, although there will be a number of technical meetings on such subjects as power plant engineering that are not related to this field.

A feature of the meeting is the number of inspection trips that have been planned, both for the men and ladies in attendance. Chief among the plants to be visited will be the River Rouge Plant of the Ford Motor Co., the continuous strip mill of the Great Lakes Steel Corp., the rehabilitated Connors Creek Station of The Detroit Edison Co. and the Springwells Pumping Station of the Detroit Department of Water Supply. Examples of production material handling methods in the automobile industry will also be seen at the Plymouth Division of the Chrysler Corp., the Chevrolet forge and axle plant, the Packard forge and assembly line and the Dodge Brothers body plant. Arrangements have also been made to visit the tire plant of United States Rubber Products, Inc.

Sessions of the program of special interest to power plant engineers are as follows:

Tuesday Afternoon, May 18, Simultaneous Sessions

1:30 P. M. Joint Session of Hydraulics and Power Divisions
The Springwells Station of the Detroit Dept. of Water Supply; W. C. Rudd, Asst. Engr. of Power and B. J. Mullen, Chief Plant Engr., Springwells Station, Dept. of Water Supply, Detroit.
Followed by inspection tour through station.

2:00 P. M. Economics Session
Economic Characteristics of Typical Business Enterprises; Walter Rautenstrauch, Professor Indust. Engr., Columbia University

2:00 P. M. Fuels Session
The Separation and Removal of Cinder and Fly Ash; Arthur C. Stern, Supt., W.P.A. Project 6010, New York.
Incinerators—Municipal, Industrial, and Domestic; H. F. Hersey, Vice-President and General Manager, C. O. Bartlett & Snow Co.
Industrial Heating and Process Furnaces; E. F. Holser, Asst. Chief Engr., Dow Chemical Co.

8:00 P. M. General Session 2 (Machine Shop Practice Division)
Chairman—Pres. James H. Herron
Vice-Chairman—Past-Pres. William L. Batt
Topic—Improved Methods of Fabrication
Recent Developments in the Basic Processes of Fabrication, viz., Casting, Forging, Welding, Machining, Pressing, and Rolling, with Social and Economic Implications, William S. Knudsen, Executive Vice-President, General Motors Corp.
Outstanding Contributions made by the Machine-Tool Builders to the Art of Building Automobiles on Mass-Production Lines, Fred W. Cederleaf, Manager of Machinery Division, Ex-Cell-O Aircraft and Tool Co.

Wednesday, May 19, Simultaneous Sessions

2:00 P. M. Condenser Session
The prevention of Surface Condenser Tube Failures; Robert E. Dillon, Supt. Prod., Edison Elec. Illum. Co. of Boston; George C. Eaton, Head, Mech. Prod. Dept., Edison Elec. Illum. Co. of Boston; and H. Peters, Asst. Prof. of Aeronautical Engrg., Massachusetts Institute of Technology.
The Condensation of Flowing Steam; John I. Yellott, Asst. Prof. M. E. Stevens Institute of Technology; and C. Kenneth Holland, Mech. Engrg. Div., Phoenix Engrg. Corp.

2:00 P. M. Fuels Session
Panel Discussion on Spreader Type Stokers, Led by J. F. Barkley, Supervising Engr., Fuel Economy Service, U. S. Bureau of Mines

2:00 P. M. Lubrication Session
Apparatus and Test Results on Dry Friction. Various Materials and Comparisons with Other Data: W. E. Campbell, Member Technical Staff, Bell Telephone Co.
Oil Film Thickness at Transition from Semi-fluid to Viscous Lubrication; G. B. Karelitz, Professor M. E., and J. N. Kenyon, Instr. in E. E., Columbia University.

4:00 P. M. Petroleum Session
The Petroleum Industry in Michigan, C. R. Miller, Consulting Engineer, Socony-Vacuum Oil Co., White Star Ohio Division.

Thursday, May 20, 2:00 P.M. Power Session

The Pooling of Power Sources in a Large Industrial Center; J. W. Parker, Vice-President and Chief Engineer, and R. E. Greene, Engrg. Div., The Detroit Edison Co.
Analysis and Tests on the Hydraulic Circuits of Surface Condensers; G. H. Van Hengel, Consultant, The Detroit Edison Co.

Friday, May 21, 9:00 A.M. Power Session

Operating Experiences in the Steam and Power Department of the South's First Alkali Plant; G. P. Avery, Supt., Power & Steam Dept., Southern Alkali Corp.
Formulas for Stresses in Bolted Flanged Connections; Everett O. Waters, Assoc. Prof. M. E., Yale University, D. B. Rossheim, M. E. Charge Mech. Design and Metal, M. W. Kellogg Co., D. B. Wesstrom, Engr., Travelers Indemnity Co., and F. S. G. Williams, Dist. Mgr., Taylor Forge & Pipe Works.

Readers' Conference

What? No, Coal! Paper Engineers Ponder

IN YOUR ISSUE of March, 1937, there appears an editorial entitled "What? No Coal!" pointing out a new process of by-product fuel recovery which threatens to save millions of tons of coal and to supply a paper mill with its entire fuel and have a surplus left over.

This article mentions that attempts have been made in the past to burn black liquor, but your article indicates that these attempts have been only partially successful.

We would be very much interested to know what this new process is, as we have been engaged in the building of paper mills for some time and from all we can gather the total heat value of all the lignines contained in the black liquor from the digesters is insufficient to supply the total heat requirements of the mill. Further, if you will investigate you will find that black liquor is being very successfully burned by existing methods.

Pittsburgh, Pa. E. R. C.

EDITORIAL NOTE: It is true that a number of recovery systems are now in successful use and the editorial was worded to avoid inferring that these did not accomplish everything intended of them. The fact that they are not in more general use, however, indicates that there is room for improvement. This need arises not from any defect or limitation in the recovery system itself, but from limitations placed on it by the paper making process with which it must work.

Waste liquor contains the non-fibrous constituents, about 50 per cent of the weight of the wood entering the process. The new Simons Process referred to in the editorial is based upon complete utilization of all pulp making materials with a full appreciation of the importance of a coordinated heat and power supply. Tradition has been forgotten and the new process applicable to newsprint, sulphite and sulphate industries automatically clears up the problem of stream and atmospheric pollution and greatly simplifies the selection of mill sites.

It is estimated that newsprint costs can be lowered from $6 to $12 per ton. This saving is due partially to a reduction of wood requirements from about one and one-third cords to about three-quarters of a cord per ton and through a reduction in power to approximately one-half of that now required.

Chemical losses are reduced, investment costs are lower and improved methods of dewatering the black liquor alone saves from 3 to 5 million B.t.u. per ton of production. The final step is the reduction of the concentrated black liquor to a granular state, which is burned 98 per cent dry.

Considering the importance of the new process to the paper industry the inventor, V. D. Simons, was requested to reply to the above letter in detail.

AFTER DISENGAGING the fibrous content of wood the organic residue has calorific value. In the sulphate pulping process this residue is a compotent of the spent black liquor blown from the digesters and thereafter separated from the fibres. It is accompanied by a lime-soda compound in solution, the aqueous content of which comprises that of the caustic-sulphidic solution in which wood is cooked under a super-atmospheric pressure and temperature plus the moisture of the wood supplied to the digesters.

Utilization of the calorific value of the spent liquor solutes is, first, for the evaporation of the solvent water; second, for the activation of chemical and the recovery of chemical solutes and, third, the generation of steam for mill process, heating and power purposes.

The greater the weight of more or less pure fibre obtained from a given weight of wood, the less is the calorific value of the non-fibrous residue. The greater the aqueous dilution of the black liquor after the fibres have been abstracted, the greater the quantity of heat required to dry the solutes to combustibility. The organic calorific value available for the recovery and activation of chemicals and the generation of steam is that which is left after the loss to the atmosphere of the total heat of any vented vapor and the sensible heat of effluent water (above the temperature of the mill water supply) evaporated from the spent liquor, recondensed and diluted by water used for washing residual black liquor out of the fibre.

Control of aqueous dilution of the spent liquor is the means by which the losses just mentioned are minimized to provide for the maximum net recovery of calorific value of combustible solutes.

Control of the purity of fibre separated from wood is the means of conserving for combustion the maximum substance of wood which is more useful for burning than for recovery to masquerade as cellulose fibre.

Gross calorific value of bark and impurities of wood together with that of sawdust and pieces shaped too irregularly to warrant cleaning them for chipping preparatory to cooking is also subject to the losses of the total heat of moisture evaporated preparatory to or during combustion. The net value obviously is enhanced by dryness and by avoiding the addition of any moisture to that of the wood when received at the mill.

The true cellulose content of most coniferous woods is accompanied by sufficient combustible solutes, the calorific value of which, plus, that of the dry wood refuse just mentioned, is sufficient, first, to evaporate a controlled weight of solvent water; second, to reactivate and compensate for the effluent and atmospheric losses of chemicals; third, to generate sufficient steam to decompose wood; fourth, to dry paper after (fifth) the generation of sufficient energy to drive the pulp and paper process motors including (sixth) those necessary to refine the fibres to produce a high grade product.

These are the reasons, when the sulphate pulp and kraft paper mill and their power plant are engineered successfully, for the necessity of no purchase of fuel.

435 N. Michigan Ave., Chicago, Ill. V. D. SIMONS.

Vacuum Problem

A VAST AMOUNT of information is contained in catalogs distributed by advertisers in various magazines, but I'm afraid the average engineer skips this part of the engineering training.

Several years ago my curiosity as to the construction and operation of a condenser, which I had seen advertised in a mechanical paper but with which I had never come in contact, caused me to write for a catalog.

By a strange coincidence, a few weeks later I was called upon to diagnose vacuum trouble in a local woolen mill and to my surprise found the identical apparatus of which I had the catalog. The engine was an old four valve 24 by 48 in. turning 60 r.p.m. and until three weeks before had carried the load perfectly, but its power had suddenly vanished and water for the

hydro plant being scarce, the mill was in a bad way for power.

In going over the condenser catalog, a weak point was noted, but I was always seeing weak points in different pieces of apparatus so I promptly forgot it. The engineer thought he had a bad vacuum leak; the exhaust pipe was hot, though no steam was spilling through the head. The discharge from the condenser was very cold, but it took water under a head and needed no vacuum pump in its operation so a cold discharge was legitimate.

After the plant had stopped that night, I tried the exhaust line for a vacuum leak, but found that I could pull 24 in., so I lifted the cover off the exhaust non-return valve (this type of condenser always safeguarded the engine with a non-return check valve), expecting to find some kind of obstruction, but everything was O.K.

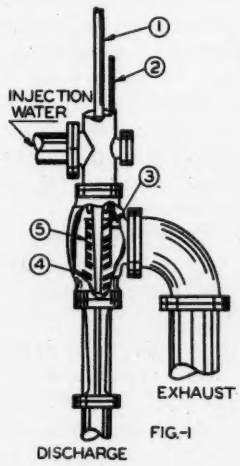


FIG.-1

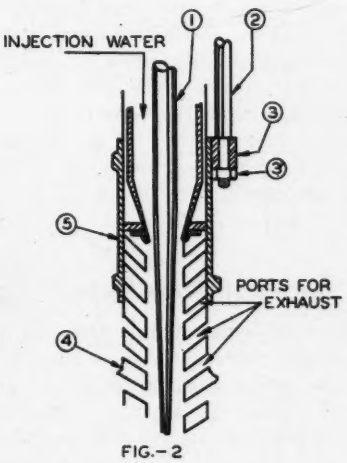


FIG.-2

① WATER RAM OR SPEAR
② SLEEVE ROD
③ SLEEVE LUG
③ SLEEVE ROD NUT
④ SLEEVE STOP LEDGE
⑤ SLIDING SLEEVE

Fig. 1. Diagram of condenser
Fig. 2. Detail of condenser sliding sleeve

Then I tried to think what my reaction had been to the illustration in the catalog; the weak point that had appeared to me. I had it! There was a sliding sleeve that I thought might get detached from the control rod.

We took off the handhole plate that allowed access to the nozzles and sliding sleeve and I felt for the lug to which the control was attached (Figs. 1 and 2). It was not attached! The threads on the steel rod had rotted away and the sleeve had dropped, covering all but a few of the exhaust ports.

After repairs had been made, which only took an hour or so, I remarked that I had sized up the illustration and come to the conclusion that the apparatus was decidedly weak in that one point and the engineer lazily replied: "You're right. That outfit has only been in operation 35 or 40 yr. and should not break." The old engine had its pep back and I got a feather or two—thanks to the catalog.

New York City. C. W. PETERS.

Horsepower of a Boiler

CONSIDERABLE confusion exists in the minds of engine and boiler operators regarding this relationship between a boiler horsepower and the horsepower of an engine or motor.

Surprising as it may be, a boiler hp. is 13.2 times as great as a mechanical hp. Here are the actual figures:

One boiler horsepower = 33,479 B.t.u. per hr.

One mechanical horsepower = 2544.6 B.t.u. per hr.

The reason for this great difference is that in the early days when boilers and engines were first made and used, a 100 hp. boiler was called a 100 hp. boiler because of its ability to supply enough steam to run a 100 hp. engine. A 200 hp. boiler could furnish enough steam to run a 200 hp. engine. And so on.

But boilers are much more efficient now than they were in the days of James Watt. There has been so pronounced an improvement that today a 100 hp. boiler will easily take care of a 250 hp. engine. Engines have improved also but not to the extent that boilers have improved. And that is why the old relationship no longer holds. But it is nevertheless a fact even today that a boiler hp., according to the modern definition of a boiler hp. is 13.2 times as great as a mechanical or engine horsepower.

It is evident that in the "old days" when one boiler horsepower produced one mechanical horsepower the efficiency of conversion was only $1 \div 13.2 = 7.6$ per cent. In other words, only 7.6 per cent of the heat energy in the steam was converted into work. Today the best plants show efficiencies that are much greater. According to my files the highest reported record is 27 per cent.

The best types of Diesel internal combustion engines are much more efficient than the most efficient steam plants. It is not uncommon for Diesel engines to produce efficiencies of more than 30 per cent.

Newark, N. J. W. F. SCHAPHORST.

Responsibilities Toward the Younger Men

WHEN YOU employed that young man in your plant, you made a contract in futures. You asked that man to give the best of his time and energy to your business. You expected his youthful enthusiasm and loyalty to be yours for the asking. That, in so many words, is what you implied when you employed him. Because you told him that, in proportion to his "success," he will be advanced and rewarded.

Do you often stop now, in your daily rounds through the plant, to talk with that young man? Do you know some of the difficulties he may be trying to overcome? Are you sure his abilities are being used to the best advantage? How many times during the past year, have you encouraged him by a personal word?

A fine old University President, Dr. David Starr Jordan, of Stanford, used to tell every incoming freshman class: "The world stands aside to let pass the man who knows where he's going!" Then he promptly went to work and helped lead them to the right path. But he had only 4 yr. with each student.

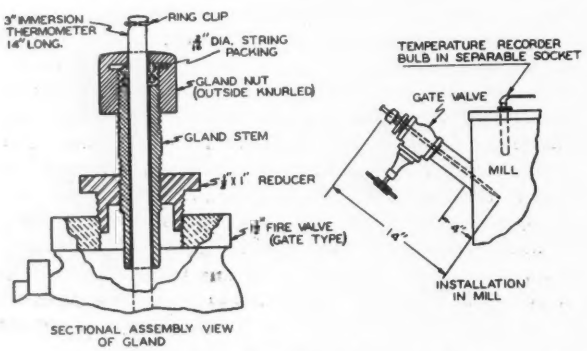
How often you, too, could lead those younger man in the right direction! You could, but maybe you're too busy. It's something to think about, isn't it?

Waterbury, Conn. LAURENCE M. DURYEE.

Thermometer Packing Gland

In order to facilitate checking pulverized coal mill temperature recorder accuracy during operation of the mill, I made up what I call a "thermometer packing gland" as shown on the accompanying sketch. Anyone who has ever had experience in checking coal-air temperatures in a mill during operation of the mill, especially if the mill is under pressure, knows that it can be a rather messy task if suitable arrangements for taking thermometer readings are not available. Not only is one likely to emerge from the test looking like a black-faced comedian, but without suitable packing around the thermometer hole an error in readings is likely to be had due to what is called "radiation error" brought about by flow of coal dust and air passed the sensitive bulb of the thermometer.

The writer realizes that the best check for recorders of this type, where the range is under 212 deg. F., is to take the bulb out of the separable socket and place in cold water and gradually heat to the boiling point,



Section and installation of thermometer gland

noting the recorder and thermometer readings during the transition period. There are times, however, when quick checks during mill operation are required and also when the chart record cannot be interrupted by a true calibration check as just mentioned. For this type of quick checking, the thermometer packing gland arrangement can be used to advantage.

With an engine-lathe at hand a gland and nut can be turned out in a very short time and at little expense. In my case I took advantage of valves which were already installed on the sides of the mills. These valves are there for the purpose of shooting fire extinguisher fluid into the mills in case of internal firing. The valves are of the gate type, otherwise they could not have been used.

The method of operation is as follows. With the valve closed, the reducer is made up to the valve finger tight. Then, the gland stem is made up into the reducer. The thermometer is then inserted into the stem and the nut is started on the stem after wrapping a few turns of string-packing around the thermometer. It will be found that after the nut has been made up on the stem a few times, the packing will stay in place with the thermometer out of the gland entirely. Now, with the thermometer in the gland and the nut loose enough to push the thermometer through the packing, open the gate-valve and push the thermometer in to its full length. As the thermometer is used bare and the bulbs on most thermometers are of the same diameter or slightly smaller than the body, a ring clip is used to safeguard the thermometer from vibrating through the gland into the mill. Readings are taken by loosening the nut, pulling the thermometer out to the point of visibility, noting the indicated temperature then pushing it back in again and tightening the nut. The packing cleans the thermometer off automatically as it is withdrawn thereby saving time and getting a quick reading. Note that the nut is knurled on the outside for finger tightening. The top of the stem next to the packing is cupped a little so that tightening of the nut squeezes the packing towards the thermometer body and away from the threads of the nut.

For testing with this arrangement, the writer uses a thermometer calibrated for 3 in. immersion as the nipple between the gate-valve and mill is quite long. It is thought that this type of thermometer approaches more nearly the true temperature than that which would be obtained with a thermometer having a full immersion calibration as there is a large amount of the stem not in the atmosphere in which the temperature is being measured. There is room for argument in either case but for the temperatures obtained in any mill operated under good conditions the stem correction would be negligible.

Kenmore, N. Y. J. C. Downing.

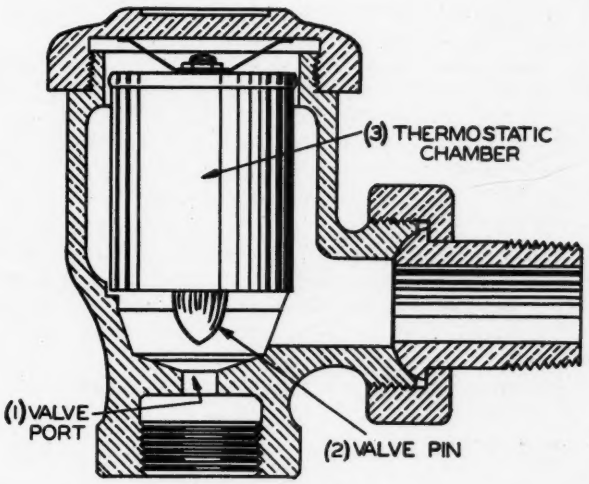
Radiator Trap Repair

In overhauling the heating system in a large building recently, I had an experience I think would be worth passing on to the readers of Power Plant Engineering. On this particular job, which is a low pressure steam gravity return system, particular attention had to be paid to the return valves or traps on the radiators. These valves are the old style type with non-removable seats. As shown in the sketch, the seat is cast in the body. The thermostatic unit with the valve pin attached is removable and can be changed from one valve to another of the same size.

These valves will be found in most all the older type homes and buildings. The valves on this particular job had not been overhauled for years with the result that 75 per cent of them were stuck fast, either in the seat or away from it. On the inside part of the thermostatic chamber it was impossible for discs to operate, due to the sediment and rust that had accumulated there. Therefore, it had been the custom to remove the valve body cap with the valve in position on the radiator, and insert a new unit. My job was to take them all off and test them on a steam table under 2 lb. pressure. I removed one floor at a time (about 50 to a floor) and tagged both radiator and valve with a number so as to avoid trouble when it came time to replace them. All the valves were taken apart and placed in a rust removing solution, then an air hose with a small nozzle was used to blow out the rust.

On examination, it was found that the valve part (1) or slat was almost perfect but the valve pin (2) was pitted and worn. After a good cleaning the thermostatic units (3) in all the valves were perfect. The only defective part in all the valves was the pin (2). After making my report on what I found, I was in-

formed a new unit would have to be installed in every valve that was found leaking. This, to me, seemed to be a very expensive procedure, all because of only one defect, so I experimented with one of the units and found that this pin (2) was fastened to the bottom of the lower disc, by a threaded pin in center, although at first glance it appears to be in one piece. By grasping the unit in my left hand and the pin (2) with a pliers I found I could screw it off. There is a small amount of solder around the pin as a precaution to keep it from coming loose but this can be broken free without any damage.



Section of radiator trap

On inquiring at the supply houses we were informed they did not carry any of the pins separately, that if we wanted the pins we had to buy the unit. We then wrote to the factory and were told they would supply us with all the pins we required, which they did, for a fraction of the cost of the element. As nearly a thousand radiators were repaired, the saving was considerable.

Philadelphia, Pa. F. G. C.

Oil Burners for Power Plants

W. A. HORKO in the April issue gives interesting and instructive arguments in favor of steam atomizing oil burners over those of the mechanical type. Answering the "disadvantage" objections to the mechanical atomizing burners which he lists I submit:

(a) The return to storage of excessive quantities of hot oil can be obviated by the initial installation and correct usage of several burners instead of trying to save primary expense by installing the fewest number possible.

(b) The heat loss from the storage tank should be negligible as, if a very large storage tank is used, the preliminary heating may be done by heating only that portion along the suction line to the pump instead of the whole tank. Furthermore, if the tank is well installed in a good compartment below the ground, the heat loss will be slight.

(c) Pumping steam at low loads will be much less if the governor is set right and objection (a) is taken care of as suggested. Cutting off one or more burners will not necessitate the return to the storage tank of the excess.

(d) I do not think this objection can be held against the one type more than against the other.

In most cases it is quite an easy job to clean the oil heater and certainly no expense is involved. What is more to the point, it can be done without interruption to conditions, as this item is in duplicate. Replacement and renewal of burner tips is certainly not a great expense.

Regarding the use of the mechanical type at sea the prime reason for this is the high efficiency shown, ease of regulation under varying conditions, no smoke condition obtainable and absolute simplicity. It is trying to run with the hare and hunt with the hounds to claim that mechanical burners are used because fresh water is at a premium and too valuable to allow use of steam atomizers. If one claims this, one minimizes the claim to very low steam consumption as, if steam consumption were as low as claimed and efficiency as high as with the mechanical type, an evaporator, part of all marine auxiliary installations, would take care of the condition and provide the necessary make-up water.

Whatever claims for low steam consumption may be advanced, and this writer says this with all respect to Mr. Darnell, who has gone into this matter very thoroughly in the current number, he can only state that the latest edition of the Mechanical World Year Book (1936) still gives the amount of steam required for steam atomized burners at a minimum of 2 per cent of the total generated and, in most cases, more. This, coming from a quite disinterested authority, will carry a lot of weight with the "innocent bystanders." The heavy flaky flame and the "sparks" can be kept down to a great extent by correct heating and use of the right tips.

In conclusion, the writer gives one personal experience to explain his preference for the mechanical type. He was boiler room engineer on a passenger vessel of 100,000 hp., with more than 40 boilers, oil fired with mechanical type burners. Each boiler had five burners. This vessel always maneuvred in and out of port under varying steam demands with all boilers on the line and never more than a 5 lb. variation in steam pressure. Incidentally, a perfectly clear stack or stacks were always obtained.

Absolute, positive instantaneous control of boiler steam is much to be desired and it has been the writer's experience that this ideal is best obtainable with the mechanically atomized burners.

Passaic, N. J. MARK BELL.

Oil Burner Performance Data Needed

I HAVE read, with a great deal of interest, the communications of J. R. Darnell and W. A. Horko, on the advantages of steam atomizing oil burners, as compared with those of the mechanical pressure type.

The statements made by both these writers as to the small amount of steam required by certain internal mixing burners are of great importance, as there are not many manufacturers of steam atomizing burners who will claim better than two per cent of the steam for atomizing, and it is difficult to get most operating men to believe that it can be done with even this amount.

I do not question the accuracy of the claims made by

either of these engineers, and certainly when we consider the burner as an energy converter, even three-quarters of one per cent of the steam generated would indicate a lower efficiency than we can get out of a steam pump such as is generally used for mechanical atomizing, and the direct acting steam pump is far from being an efficient steam engine.

At the same time, in view of the large steam consumption of some of the steam atomizing burners, it would be of the greatest value, if we could get reliable data from as many sources as possible, on the amount of steam required for atomizing under normal operating conditions.

I am quite inclined to believe that it is possible to design an internal mixing burner which will take a good deal less steam than one of the external mixing type, but it is important that we should get the most reliable operating data on this, because it is a simple matter to figure with considerable accuracy the amount of steam required to pump a given weight of oil against any required pressure, when using a pump of the average efficiency, for operating a mechanical burner.

This being the case, the manufacturer of the mechanical burner has little difficulty in convincing the prospective purchaser that any reasonable claims can be lived up to in practice, whereas with the steam atomizer the situation is quite different, and more reliable data as to the steam used for atomizing, together with information which would help us to form correct conclusions as to the cause of the wide range of steam consumption found in different burners, would be of the greatest value.

I quite agree that under varying load the steam atomizer has advantages. Unfortunately it appears to be always possible to find test data, apparently obtained in perfectly good faith, which will show that any particular type of equipment is highly efficient. This appears to be one of the unsolvable mysteries of the engineering profession, but any one with any experience knows that it is true.

Why the mechanical burner referred to by Mr. Horko showed up so badly, I do not know, but I do know that many reliable tests have shown that the mechanical burner can, under proper conditions, be very efficient, and this is also to a large extent true of the steam atomizing type.

I do not think that there is any excuse for overheating the oil in the tank when operating a wide range mechanical burner, since if the installation is properly laid out, a by pass connection should be provided returning the oil to the pump suction for repumping instead of returning it to the tank. The temperature of the oil delivered to the burners should of course be controlled automatically and should be independent of the temperature at the pump suction.

It is undoubtedly true that there is a certain loss due to the fact that the same amount of oil is pumped at all loads with wide range mechanical burners, but even at low loads the amount of steam used for this purpose is probably considerably less than the atomizing steam used by most steam operated burners, especially when we consider that with mechanical operation the pump takes care of both circulating and atomizing, moreover, exhaust steam from the pumps can often be used for heating, whereas atomizing steam is lost.

In this connection, although it is common practice to use live steam only, for heating the oil for mechanical burners, exhaust steam can be used to advantage if we have two heaters in series, the second heater being supplied with live steam to take care of the peak temperature.

From personal experience I would say that there is a field for both mechanical and steam atomizing burners, and either one may prove to be the most efficient under the right circumstances, but there is no doubt that many steam atomizing burners are extravagant in the use of steam, and almost any burner of this type may be operated extravagantly if care is not taken, therefore any information as to what has been done in practice to keep the steam consumption down is of the greatest interest, and both Mr. Darnell and Mr. Horko have rendered a service to readers in publishing the data which they have.

Bloomfield, N. J. JAMES O. G. GIBBONS.

Safety in Reverse

IN ONE of the large hotels in an important Mexican city, in the spacious lobby was a single elevator of the type popular in American cities 20 yr. ago. It stands in splendor, next to the staircase and away from the wall and goes up for seven stories with its handsome open wrought iron grill work cage and enclosure. It moves slow and not very often and takes but two people, besides the operator, on the up trip, although there is room for twelve on the down trip, however, all that can cram into it may ride. An attendant confided to me that it was necessary to limit the number on the up trip as a heavy load might part the badly weakened cables and as the car came down by itself anyway there was no limiting necessary on the number of people allowed in the cage on the down trip. It was the busy season, with the lobby full of people and as only servants are supposed to use the stairs in Mexican hotels, the guests just wait their turn going up. What a far cry from modern rigid safety inspection requirements for the protection of the traveling public!

San Francisco, Cal. RAY B. WOLF.

Failure of an Inching Motor

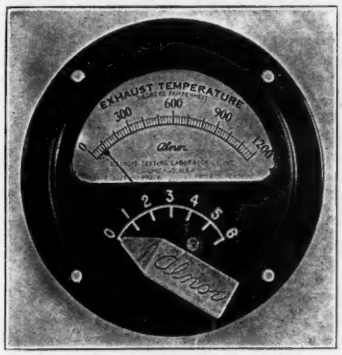
A 25 hp. squirrel cage induction motor running at 415 r.p.m. used for inching a large machine failed due to overspeed. The motor was connected to the machine through a clutch and speed reduction gear, the clutch being arranged to free the motor when the speed rose to above a certain speed when the main motor was started. The failure occurred when starting up, the clutch failed to release the rotor of the inching motor when the main motor attained a certain speed, with the result that the rotor was driven by the main motor at a speed of almost 4000 r.p.m. This caused the rotor bars to fail. When motors are used for this work attention should be paid that the clutch releases the armature shaft when a certain speed is exceeded. Frequent cleaning and good lubrication is essential, as stiff working of the clutch is often due to dirt and congealed lubricant or defective lubrication.

Sussex, England. W. E. WARNER.

New Equipment

Diesel Engine Pyrometer

DESIGNED especially for measuring the exhaust temperatures of small Diesel engines, the new Alnor Type 3023 round style pyrometer with a self-contained selector switch is offered by the Illinois Testing Laboratories, Inc., 420 N. La Salle St., Chicago, Ill. It is furnished in 2, 4, 6, 8, 10 or 12 points with a scale range of 600,

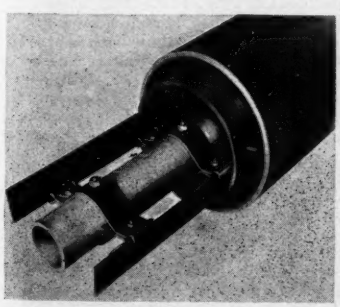


800, 1000 or 1200 deg. F. The extreme case diameter is 4 in. and the depth, including the terminals is 2¾ in. It is made for flush mounting on a panel, direct mounting at the engine or remote mounting as desired.

Shell and Tube Oil Chiller

THIS NEW EQUIPMENT of York Ice Machinery Corp., York, Pa., has features of design worked out by its research laboratories to facilitate obtaining the low temperatures required in multiple-stage chilling of low cold test oils, and it will be of value in rapid refrigeration in other industries where low temperatures are needed. The new eight shell unit is 23.5 by 5 to 10 ft., with 1170 sq. ft. effective chilling surface, requiring about 65 per cent of the space formerly needed for a like chilling surface. One packing gland to 146 sq. ft. of chilling surface and a special method of design and operation result in avoidance of loss of solvent. Specially designed scrapers keep tube surfaces cleaned of wax as is also the case in the double pipe chiller, arrangement of mechanism being such that scrapers are kept alined with pipes, eliminating "teeter" and strain on moving parts.

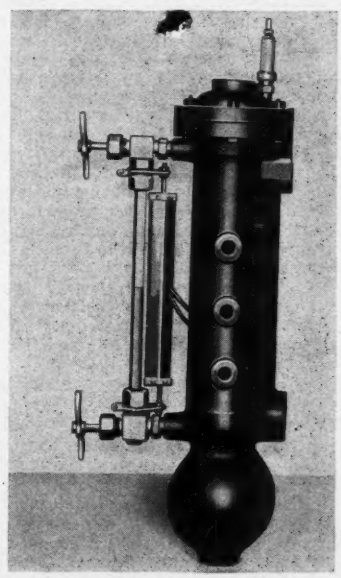
This new chiller, with the York booster



and stage compressor and York ammonia liquid circulating system, is designed to give economical and dependable production of low temperatures in line with the company's effort to broaden application of refrigeration and air conditioning in industry.

Neon Water Gage Illuminator

A SIMPLE device for the quick and certain reading of water gages has recently been developed. It consists of a Neon light tube and a magnifying lens placed behind the water gage, attached by two screw clamps which grip around the top and bottom water gage fittings. The water or liquid filled part of the gage glass stands out as a broad neon red band, the empty space above appearing as a hair line red stripe. The water level can be read distinctly, day or night.



The manufacturers claim that this new Illuminator gives clear visibility of the actual water level at a distance of 150 feet or more under any conditions.

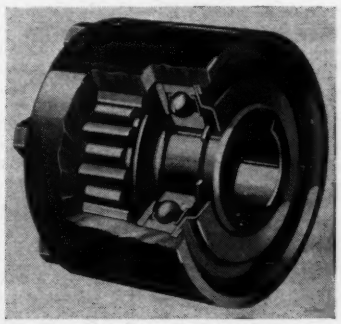
This new Neon Illuminator for easy reading of water gages was developed by the Wright-Austin Company of Detroit.

Free-Wheeling Clutch

NEW FEATURES are incorporated in the design of a high-torque indexing and free-wheeling clutch just announced by the Morse Chain Co., Ithaca, N. Y. A few of its many uses are found in machine tools, printing presses, stokers, ventilating fans, automatic heat treating furnaces, and special machinery.

In this new clutch, multiple cams are used, spaced alternately with hardened ground steel rollers to distribute the load evenly on each cam, a feature which permits high torque loads without danger to the cam surfaces and allows greater cam contact surface for a given clutch diameter.

Cam action is governed by two leaf springs that contact shouldered surfaces milled at each end of the cams. The point of spring contact is such that a rocking action is created, with the fulcrum point at the center of the cams. Thus, when

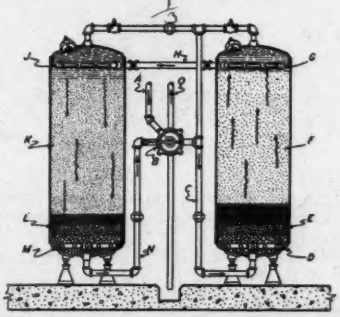


the speed of the inner and outer races synchronize, the cams immediately roll into a locking or driving position. The profile of the cams has been scientifically developed so that grip and breakaway are remarkably precise, without noise or shock.

A ball bearing at one end separates the members and stabilizes the load. The opposite end of the unit is prepared for the attachment of sprocket wheel, ratchet arm, or belt pulley. Lubrication is self-contained.

Two-Flo Zeolite Water Softener

ELGIN SOFTENER CORP. of Elgin, Ill., is offering a new design of zeolite softener combining up flow and down flow with a single valve controlling the flow for softening and backwashing. For either operation, water enters through pipe A to valve B. In the illustration, which shows the



flow for softening, water passes through pipe C to the lower end of the right hand unit, through manifold D, upward through gravel bed E and zeolite bed F and is collected by a manifold G. Valves in the pipe connecting the tops of the two units are closed, so that water passes through pipe H to manifold J, then down through zeolite bed K and gravel bed L to manifold M, and out through soft water outlet N to pipe O, the soft water supply line.

In backwashing, valve B is turned so that water flows from A to pipe N, to

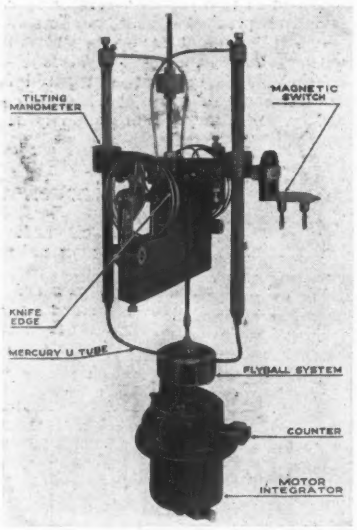
manifold M and up through the left-hand unit. Valves in the connecting pipe at the top are adjusted so that one-third of the water goes out the top of the left-hand unit to the vertical drop pipe; the balance passes through H to the manifold G, then a second third flows out the top of the right-hand unit to the vertical drop, the last third passing down through the zeolite and filter beds to manifold D then up through C to valve B. All the backwash water is passed through B and out of the vertical pipe at the bottom to the sewer.

Objects of the design are to use small and deep beds of zeolite, so as to obtain large capacity, to trap the zeolite so that none will be carried away either in softening or backwashing, to provide rapid backwashing with a minimum amount of backwash water, to simplify operation by means of the single valve to control flow.

Existing systems can be adapted to the two-flow principle, by changes in piping where the present installation is a two-unit plant, or by addition of a tank and repiping where a single unit is in use.

Centrimaxflow Meter

BASED ON centrifugal action and direct integration the Centrimaxflow Meter of Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa., is a departure from conventional flow meter design.



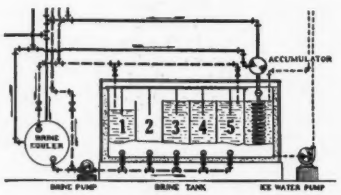
A pressure differential across a primary element is balanced against centrifugal force exerted by a flyball system. As both factors involve a square root relationship the speed of the rotating system bears a linear relation to the flow.

As shown by the illustration, the meter consists primarily of a tilting manometer, balanced on a knife edge and carrying a magnetic switch. An increase in manometer pressure, tilts the beam to close the magnetic switch and speed up the motor driven flyball system until the centrifugal force rebalances the beam. The switch alternately opens and closes to keep the two forces balanced.

The motor is thus kept running at an average speed which is a linear function of the flow. The integrator is a counter geared directly to the motor shaft, but a remote counter may be provided if desired. Remote indicators, and either strip or round short recorders are also available. As a result of extensive tests, integration guarantees, exclusive of the primary element, are to within plus or minus 0.5 per cent at 100 per cent flow and plus or minus 1.0 per cent at 25 per cent flow. Usual errors at the primary element may be compensated for at the balance by a simple adjustment.

Brine Tank

CONSTANT TEMPERATURE BRINE TANKS have recently been developed by the Carbondale Div. of the Worthington Pump & Mach. Corp., Harrison, N. J. The tank is divided into a number of compartments arranged in such a way that the cold brine is not affected by the warmer return brine.



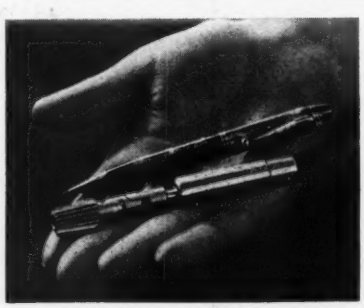
With compartments Nos. 1, 2, 3, and 4 full, consumption of brine begins from compartment No. 4, compartment No. 5 being empty. The brine pumped from No. 4 returns into No. 5. As soon as No. 4 is emptied, brine is taken from No. 3. The warm return brine still returns to No. 5, which eventually fills up and overflows into No. 4. The operation is progressive and there is no mixing of the warm return brine with cold brine in any of the compartments.

Tube Cleaners

CLEANING small tubes, such as are found in condensers, heaters, heat exchangers, and marine boilers, with a small cleaner which enters the tubes, has been a tough problem for the tube cleaner manufacturer.

Elliott Co., Jeanette, Pa., has during the past several years, been devoting considerable time and study to the development of satisfactory small tube cleaners. The results, which are now being announced, are known as the 600 Series cleaners, made in a range of motor diameters from 15/32 in. to 1 7/16 in. They are suitable for use in both straight or curved tubes.

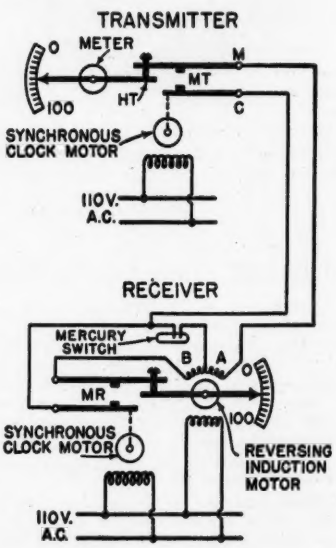
The general design of the motors is the same as the Lagonda standard air-driven motor, using a rotor with four paddles, and although parts come very small in these small sizes, these motors develop just about the maximum power possible within the size limitation. These cleaners are suitable for operation on air pressure up to 100 lb. and they consume from 10 to 30 c.f.m., depending upon the size. They may also be operated by steam.



Complete equipment furnished with these cleaners includes the motor, universal coupling, six threaded cone cutters, three adapters, an extra set of paddles, sight feed lubricator, wrenches, and 25 ft. of operating hose with couplings.

Bailey Flow Meter

KNOWN AS the Synchro-Meter, a new electrically-operated flow meter has been developed by Bailey Meter Co., Cleveland, O. Basically, this consists of a transmitting unit, operated by a Ledoux bell flow measuring mechanism of the type used in standard Bailey mechanically-operated fluid meters, and a receiver, consisting of the indicating, recording and integrating instruments. No adjustments of the Synchro-Meter are necessary at the transmitting end. It may, therefore, be located in a relatively inaccessible place and several receivers may be operated from one transmitter.

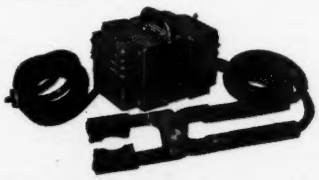


Calibration of the Synchro-Meter transmitting system is simple and permanent. Two scales, one on the transmitter and the other on the receiver, make it possible to test the transmitting system without calibrating the flow measuring element and conversely, to calibrate the flow measuring element without using the electrical system.

As shown diagrammatically in the wiring diagram, the Bailey Synchro-Meter Transmitter consists essentially of the mechanically-operated measuring device, or meter; two contact arms swinging about points M and C; ond a constant speed cam arranged to swing the lower contact arm in a continuous reciprocating cycle. The upper arm is positioned by the flow measuring device through the mechanical stop HT. The Indicating, Recording and/or Integrating Flow Meter Receiver operates in a similar manner except that in this case the upper contact arm is positioned by the reversing induction motor.

Large Thermo-Grip Electric Pliers

THE No. 5 Model Ideal Electric Pliers was introduced several months ago as a new and novel type of electrically heated soldering tool for small soldering work. Shortly after this tool was placed on the market, there appeared a demand for a similar tool, which would handle larger work, and as a result the Ideal Commutator Dresser Company, 1033 Park Avenue, Sycamore, Illinois, has developed the Ideal No. 10 Electric Pliers, which will do work over twice the size of that for which the No. 5 is used.



The larger size Pliers are used for soldering lugs up to 1050 amp. or sweating pipe fittings up to 2½ in. diameter, under continuous operation. When used only intermittently, the No. 10 Pliers will handle pipe or fittings up to 4 in. in diameter.

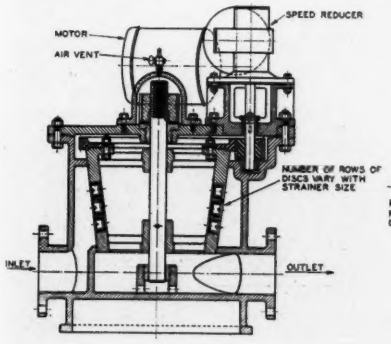
Automatic Strainer

SELF-CLEANING operation and a new type porcelain filter are features of the automatic strainer offered by H. A. Brassert & Co., 310 So. Michigan Ave., Chicago, Ill. This strainer is made in inlet sizes ranging from 1 to 36 in. and is particularly well suited to industrial services where a high percentage of foreign material must be removed from large quantities of water or other fluid.

Essentially, the strainer consists of a conical drum revolving in a cast-iron housing. The side of this drum is filled with holes 1⅜ in. in diameter so arranged that screening discs are held in place by retaining rings. The screen may be brass, monel metal or stainless steel cloth, or, a new type of porcelain disc filter which is non-corrosive, acid-resisting and has proved to be effective in the screening of fibrous materials without clogging.

The cylinder is revolved slowly by a self-contained motor, water entering the housing passes through the straining media to the interior of the cylinder and is discharged downward. Once each revolution the filter discs pass in front of a wash-out connection where a reverse flow automatically cleans the straining media.

Filters are built for 125 lb. pressure and the pressure drop through them under ordinary conditions is 2 lb. About 5 per cent of the total input is required for backwashing.



Atlas High Pressure Reducing Valve

AFTER COMPLETING a number of service tests, the improved Type "E" forged steel body high-pressure reducing valve for oil as well as water and air has been announced by The Atlas Valve Company, 282 South Street, Newark, N. J.

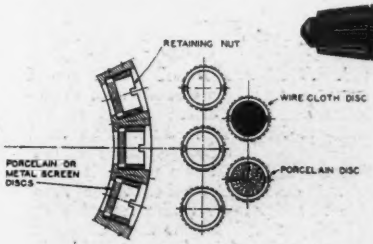
Some of the important features which combine to make the valve truly modern in every respect are the stainless steel, internal metal parts, a formed packing of special material superior to leather has been adopted which is immune not only to water but to oil and other fluids commonly used in hydraulic machinery.

The pressure on the seat is balanced by a piston with the result that variations in high initial pressure have little effect on the reduced pressure.

Bacteria Control

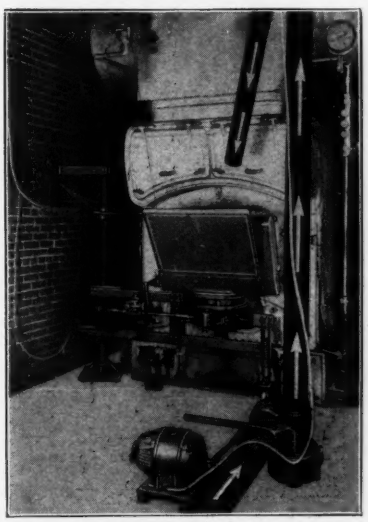
IN MANY TYPES of air-conditioning systems, economy requires the re-use of the water employed for washing or scrubbing the filtered air before it is returned to the rooms that are being conditioned. It is a known fact that a considerable amount of organic matter from re-circulated air is introduced into the re-circulated wash-water, providing sufficient food material to allow bacteria to grow and increase rapidly. Due to this, algae and slime growths accumulate on surfaces directly in contact with water, and thus interfere with the efficient operation of the system. In addition, surfaces of coils used for heating and cooling air also accumulate deposits and re-infect the washed air, so that air washed with water of high bacterial content or that contacts bacterial growths on surfaces, becomes a carrier of infectious organisms detrimental to health.

Oakite Products, Inc., 22 Thomas St., New York, N. Y., has developed a new material known as Oakite Airefiner that, it is claimed, successfully solves this problem. When added to the re-circulating water used to wash or scrub air, it keeps the wash-water sterile and prevents the growth of slime and algae deposits in the system. This new material is completely soluble, transmits no odor to water or air, and provides a stable, colorless solution that is safe and non-toxic. It is non-corrosive to metal surfaces and helps prevent water scale formation.



Overfeed Stoker

THE KIRBY MFG. CO., 238 Union St., Decatur, Ill., announces its new overfeed stoker is now available in a complete range of sizes from small domestic units up to 150 hp. boilers. It is particularly well adapted to conversion of handfired furnaces. No grates need be removed. The stoker, adjustable for different size firing doors, may be swung out to allow removal of ash, clearing or in case of power failure, hand firing.

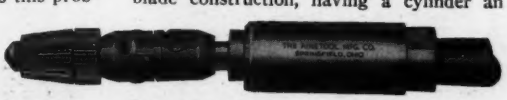


Coal is elevated to a hopper by a screw conveyor automatically controlled by the coal level. From the hopper, coal passes by gravity to a motor driven distributor head and is distributed over the grates by centrifugal force. Lugs on the distributor are adjustable to give complete and even coverage of different sizes and shapes of grates. The illustration shows an installation in the St. Anthony Hospital at Effingham, Ill.

Small Tube Cleaners

AIR DRIVEN tube cleaners for the cleaning of small tubes have been developed by the Airetool Mfg. Co., Springfield, O.

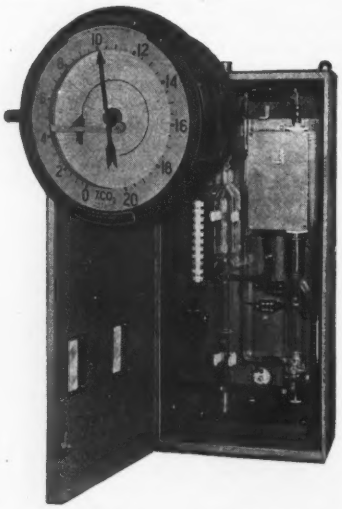
This cleaner is of a two stage, four blade construction, having a cylinder an



integral part of the case and the exhaust is so arranged as to eliminate all back pressure on the motor. The motor can be arranged with either a cutter head, brush or scraper for the removal of foreign matter depending upon its nature. This tool was developed primarily for the cleaning of condensers and heat exchangers but can be used in all small tubular construction ⅜ to 1½ in. in diameter where there is any foreign matter to be removed.

CO_2 Equipment

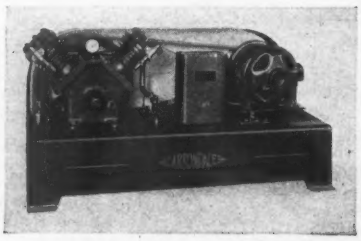
USING A SIMPLIFIED CELL assembly which conditions a flue-gas sample by saturating rather than by drying it, an improved equipment is announced by Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. for use in continuous CO_2 recording with its thermal-conductivity method either as a guide to manual regulation, or as a check on the correctness of automatic control.



Details of the Micromax CO_2 recording equipment which uses the new, saturated-gas cell and operates on alternating current throughout is given in catalog N-91-163.

Refrigeration Units

SELF CONTAINED, low-pressure refrigerating units of a new design have been announced by Carbondale Div. of Worthington Pump & Mach. Corp., Harrison, N. J. These units are designed to employ either freon or methyl chloride as a refrigerant and are recommended for both air conditioning and general refrigerating purposes. To meet modern operating requirements, both suction and discharge valves are the well known light-weight, quick-acting, Feather type, and the V-type compressors range from 4 to 8 cyl., depending upon the capacity.

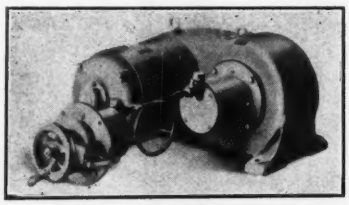


Electric motor drive to the compressor is the well known Multi-V-Drive. Safe operation is assured by inter-locking the motor starter, and the high-pressure cut-out. Starting is accomplished by means of pressure or temperature changes and uses the usual automatic starting features. The receiver is integral with a shell-type condenser which is fitted with copper-finned condensing tubing and is of welded construction throughout.

Hydraulic Remote Control of Variable Speed Units

A NEW DEVELOPMENT in the U. S. Varidrive Motor as shown in the accompanying illustration, is an arrangement for the remote control of variable speed units by hydraulic means.

The operator can vary the speed of the compact Varidrive unit over a wide range of speeds by turning the handwheel at the



remote control station. The remote control is hydraulic and provides a smooth regulation of speed and an infinite number of speeds within the speed range provided. The liquid at the remote control station cylinder is forced through copper tubing to the cylinder at the variable speed unit itself and the movement of this cylinder changes the speed.

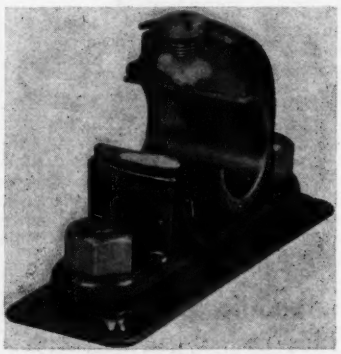
Air Conditioning

NEW UNIT air conditioners with a wide range of air and refrigeration capacities is announced by the Carbondale Div. of Worthington Pump & Mach. Corp., Harrison, N. J. Each element is a complete and separable section in a compact cabinet, making assembly easy and speedy. One section contains the complete fan assembly with motor, another the complete coil and humidifying assembly, and another the base and cleaning elements. Any section may be shipped or handled separately.

A complete air conditioning job, including cooling and dehumidifying, heating and humidifying, and cleaning and air circulation is accomplished by these units. They are available with or without humidifying and heating elements.

Noiseless Bearing

AN INSULATED BEARING to absorb vibration and noise from revolving shafts has been designed by the Dodge Mfg. Co., Mishawaka, Ind. The bearing is self-oiling, providing oil for the shaft by capillary action from the reservoir contained in the cast



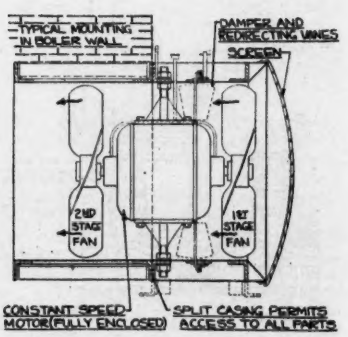
iron inner housing. Oil from the reservoir flows through absorbent material to a porous bronze liner or bushing which absorbs oil equal to about one-third of its volume.

Vibrations and sounds from the moving parts of a shaft bearing, designed primarily for air conditioning and heating apparatus, are absorbed by bands of neoprene, the chloroprene rubber manufactured by the du Pont Company, inserted between the inner unit and the outer casting of the bearing.

Motorized Blower

KNOWN AS the Type COM, a new design of blower has been developed by L. J. Wing Mfg. Co., 14th St. and 7th Ave., New York City. By a two-stage combination, the pressures and volumes required for forced draft and similar work are obtained at low, quiet, constant speeds, regulation of the air volume being secured by built-in control and redirecting vanes. The drive motor is self-contained and the units built for both horizontal and vertical mounting.

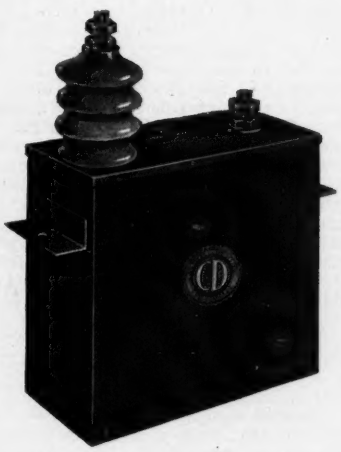
Designed especially for forced draft


TYPICAL MOUNTING IN BOILER WALL
DAMPER AND REDIRECTING VANES
SCREEN
2ND STAGE FAN
1ST STAGE FAN
CONSTANT SPEED MOTOR (FULLY ENCLOSED)
SPLIT CASING PERMITS ACCESS TO ALL PARTS

service for hand, stoker, oil or gas fired boilers, or for secondary air supply for pulverized fuel they may be installed directly in the brick setting or concrete foundation wall or mounted separately as desired.

New Compact Capacitors

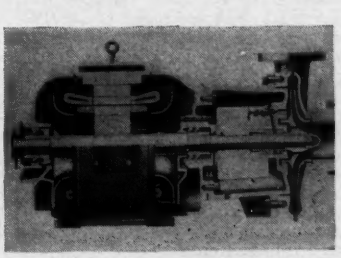
THE POWER FACTOR Division of the Cornell-Dubilier Corp., South Plainfield New Jersey, announces the development of a new line of outdoor capacitors for power factor correction on public utility distribution systems. These capacitors are so constructed that they are suitable for mounting on small frames directly on poles and do not need external housings. By using this construction the installation and maintenance costs are kept at a minimum.



The units are supplied with either one or two bushings and in voltage ratings from 230 to 6900 v. Two kinds of units are available—one impregnated with Dykanol A and the other with Dykanol C, both of which are so designed as to give trouble - free service over a long span of years.

Motor-Mounted Pump

NEW LINE of motor driven centrifugal pumps for capacities of from 5 to 1200 g.p.m. and heads of 10 to 230 ft. is announced by the De Laval Steam Turbine Co., Trenton, N. J. The pump is mounted upon the end bell of an electric motor, the two forming a compact and self-contained unit, with only one shaft and two bearings. A motor-mounted pump is shipped ready for immediate connection to piping and power supply line and can be installed with the shaft horizontal, vertical, or inclined, or the unit can be mounted upon a hand truck or suspended from a sling. The pump is suitable for any usual liquid in industrial and process plants. The pump casing is of cast iron, while the impeller, wearing ring, shaft sleeve, stuffing box gland and lantern ring are of bronze, or of special materials where required. Parts are interchangeable, all pump parts being removable without disturbing the motor.



TRANSITE PRESSURE PIPE, as announced by Johns-Manville Corp., has been approved by the National Board of Fire Underwriters for use in underground water service for pressures up to 150 lb. per sq. in. and in sizes 4 to 24 in. diam. It is stated that this asbestos-cement product has a 20-yr. record of service in Europe and for 9 yr. has been installed in many water systems in the U. S. A. and Canada. The National Board checked experience with the pipe in Europe and America, also methods of manufacture, and made extended laboratory tests on pipe, fittings and joints for pressure, flexure, impact, crushing and deterioration by chemical action.

Gravelite for Concrete

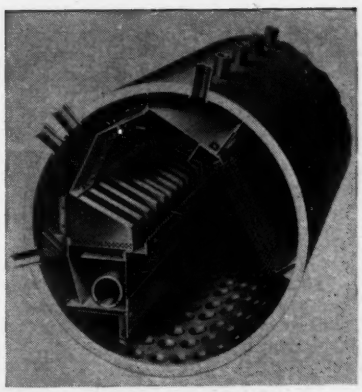
IN ORDER to save weight in the flooring of the San Francisco-Oakland bridge, a new aggregate for concrete was developed by forming small, short cylinders of ground clay mixed to a paste with water, then roasting these in a rotary kiln when they expand to twice their size, becoming so light that they will float in water. The aggregate is sized, then used in the same way as rock or gravel. It has been used for monolithic and reinforced concrete construction in industrial buildings, private homes and at Boulder Dam, the advantages being saving of one-half in weight, better heat insulating properties and high resistance to cracking. The material is produced by Gravelite, Inc., at Port Richmond near San Francisco.

Steam Washer

DEVELOPED by Combustion Engineering Co., Inc., New York, N .Y., a steam washer removes entrained solids from the steam by forcing it to bubble through clean feedwater. The washer has been subjected to long and extensive tests under regular operating conditions in one of the large power stations and as a result of the satisfactory performance a number of subsequent installations have been made.

The feedwater enters the trough at the lower left through the longitudinal perforated pipe and spills over the notched weir. Mounted over the trough are a series of compartments, or hoods, open at the bottom and left and having perforations near the bottom of the side walls. These hoods are joined together by plates at the left and over them is bolted a continuous plate which extends to the top of the drum.

Steam entering the drum through the tubes at the left is compelled to pass into the hoods and out through the apertures, and bubbles through the feedwater, in which operation the entrained solids are removed. The actual washing of the steam is obtained not alone by bubbling through the water but also by the violent mixing of steam and water between the elements as created by the velocity of steam through the perforations. The construction is such as to prevent co-mingling of the feedwater with the water in the drum. The screen at the right is for the removal of moisture that may be carried along with the steam.



The washer is so located as to leave space for ready access for cleaning without removing it from the drum. However, should it be desired for any reason to remove the washer this may be readily done in sections, as the parts are bolted together.

SINGLE SUCTION, centrifugal pumps, especially engineered to handle corrosive liquids and designed to be furnished at low cost in a wide selection of special alloys are offered by the Lawrence Pump & Engine Co., Lawrence, Mass. This unit, known as the Type SC, Vortex pump, is made of a number of alloys or combination of alloys to meet the exact needs of every installation.

Ball bearing construction, extra deep stuffing boxes and a vertical split casing, making all parts readily accessible. For evaporator and similar service there is available a stuffing box with an outside type of pot seal, which, when completely filled with liquid, shuts out all air, an important feature when operating under high vacuum.

New Officers for I. S. A. A.

A. W. AKINS, Supt. of Power and Mechanical Depts., Standard Oil Co. of N. J., Bayonne, N. J., was re-elected President of the Industrial Smoke Abatement Association of Hudson County, New Jersey, at the monthly meeting, March 18. The annual election of officers and directors of the Association was held in connection with the regular monthly meeting. G. H. Binder, Asst. to President, Callite Products Co., Union City, was elected, First Vice-President; Second Vice-President, W. L. E. Keuffel, Secretary, Keuffel & Esser Co., Hoboken; Third Vice-President, J. S. Hollowell, Supt., Natural Products Refining Co., Jersey City; Fourth Vice-President, G. A. Anbro, Plant Engineer, Colgate-Palmolive-Peet Co., Jersey City; Secretary, H. Yunker, Chief Engineer, Jersey City Printing Co., Jersey City; Treasurer, J. Gerhard, Chief Engineer, Swift & Co., Kearny; Directors, A. Baumann, Manager, Consolidated Bleaching Co., Union City; E. S. Bell, Supt., United Africa Co., Guttenberg; J. H. Brautigam, Genl. Supt., Worthington Pump & Machinery Corp., Harrison; F. L. Bryant, Chief Engineer, Franklin Baker Co., Hoboken; H. R. Cady, Mechanical Engineer, Hackensack Water Co., Weehawken; H. C. Frank, Asst. Professor of Physics, Stevens Institute of Technology, Hoboken; F. D. Lohr, Supt., Koppers Gas & Coke Co., Kearny; W. Olsen, Supervisor Power Plants, New York Central Railroad, North Bergen.

This association was organized last year to coöperate with William G. Christy,

smoke abatement engineer of Hudson County and his staff. The organization is an outgrowth of the Industrial Fuels Conference held in Jersey City in March, 1936, under the auspices of the Hudson County Department of Smoke Regulation.

Professor H. C. Frank of Stevens Institute of Technology, Hoboken, was the principal speaker at the meeting and told the results of the air pollution survey carried on in the Metropolitan District by Stevens Institute in coöperation with the U. S. Weather Bureau. Stations are maintained at Castle Stevens, roof of the Whitehall Building, New York City, and the Weather Bureau Observatory in Central Park. Professor Frank's records show that air pollution has been reduced more than 65 per cent since 1931, when the survey started.

Gas Power for Chicago

GAS FOR INDUSTRIAL POWER is now available through the Gas-Motor service rate of Peoples Gas Light and Coke Co., which has been approved by Illinois Commerce Commission. During the summer months, May to Sept. inclusive, the company has large excess capacity because of the low heating load, and some excess is available in April and October. The rate for gas for industrial power is, therefore, set to encourage summer use, the same engines to be driven in winter by fuel oil. Rate for May to Sept. is 3 cents per therm for the first 1500 therms per month and 2.25 cents per therm for all in excess of that figure. During April and October, the rate is 4.25 cents per therm and for the rest of the year, Nov. to March inclusive, is 12 cents per therm.

Gas motors used will be of the automobile type, requiring little attention and with push button or automatic control for starting and stopping, but running at low speed of about 400 r.p.m. First installation is of two 400-hp. motors driving 265-kw. generators made by Chicago Pneumatic Tool Co. for Armstrong Paint & Varnish Co.

Drive from the gas motors may be by mechanical transmission or to an electric generator. Service will be suitable for machine shops, garages and industrial plants.

Boulder Completes Initial Installation

COMPLETION of the initial installation of generating equipment at the Boulder Dam power plant was reported on March 31 by John C. Page, Commissioner of Reclamation.

Four generators, each of 82,500 kv-a. capacity, have been installed, tested and placed in operation on the line serving the City of Los Angeles. All of these units are in the Nevada wing in the huge horseshoe-shaped power house, which lies in the bottom of Black Canyon at the toe of Boulder Dam.

Installation will begin immediately on the generators and turbines for Units N-5 and N-6, which will produce power for the Metropolitan Water District of Southern California. These generators will also be of 82,500 kv-a. capacity. Plans and specifications are being prepared for two more of these big units to be installed in positions A-6 and A-7 in the Arizona wing for the generation of power for the Southern California Edison Co. These units are expected to be ready for operation by the summer of 1939. A 40,000 kv-a. unit has been installed in Position No. 8 in the Arizona wing of the power plant.

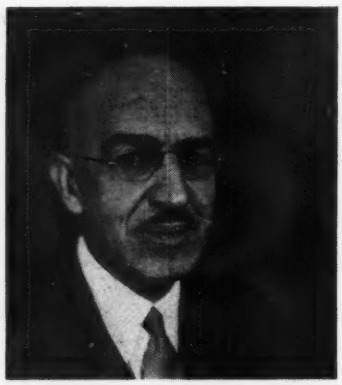
When the Boulder Dam power plant is fully equipped, it will contain fifteen large units and two smaller units with a total capacity of 1,835,000 hp. or 4,330,000,000 kw-hr. annually.

The four large generators already installed cost at the factory a total of $2,620,001, while the four 115,000-hp. turbines, which are parts of the units, cost $1,091,309. Each unit, with the cost of installation, and the necessary controls, switching equipment, etc., cost approximately $2,240,000, or a total for the initial installation of $8,960,000. Two of the generators were manufactured and installed by the General Electric Co. and two by Westinghouse Electric & Mfg. Co. The turbines were manufactured by the Allis-Chalmers Mfg. Co. and were installed by the Bureau of Reclamation. Installation of generating equipment was begun October 11, 1935.

The power is transmitted to Los Angeles over two 60-cycle, 3-phase circuits, each 266 mi. long. These transmission lines were built by the City of Los Angeles. They will carry a voltage on the sending end of 287,000 v., the highest voltage for which any transmission line has been constructed in this country.

Tapscott Heads Consolidated Edison

AT THE ORGANIZATION meeting of Consolidated Edison Company of New York, Inc., held March 17 at 4 Irving Place, Oscar H. Fogg, formerly executive vice-president, was elected to the newly created position of vice-chairman of the board and Ralph H. Tapscott, formerly vice-president of Consolidated Edison in charge of electrical operations within New York City, was elected president and a trustee. Mr. Tapscott succeeds Frank W. Smith who, at his own request, was not re-elected to that office in view of his impending retirement at the end of June under the companies' age limit of seventy.



Ralph H. Tapscott

Floyd L. Carlisle, Chairman of the Board of Trustees, was re-elected to that office, and the following vice-presidents were re-elected: F. H. Nickerson, R. B. Grove, W. Cullen Morris, A. H. Kehoe, E. F. Jeffe, J. C. Parker, Philip Torchio, John Stilwell, and W. W. Erwin. N. T. Sellman was re-elected assistant vice-president; H. C. Davidson, secretary, and J. R. Fenniman treasurer. Henry Obermeyer, director of the Advertising Bureau, was elected an assistant vice-president.

Oscar H. Fogg (Blank & Stellar, photo)

Mr. Smith will continue as a member of the Board of Trustees. Also, until his retirement, he will continue as president of Brooklyn Edison Company, Inc., and as president of the New York and Queens Electric Light and Power Company.

Oscar H. Fogg entered the gas industry with the United Gas Improvement Company in Philadelphia, where he was born. In 1904 Mr. Fogg was employed by Consolidated Gas Company in its department of mains and services. Six years later he was assigned to handle research problems, including an investigation of gas making processes, utilization of by-products of gas manufacture and kindred subjects. During the World War Mr. Fogg was engaged in the designing of plants for repair and maintenance of ordnance material in France, also in recruiting and in organizing and training enlisted and commissioned personnel.

When he was discharged from the army in 1919 Mr. Fogg became Secretary-Manager of the American Gas Association, newly formed by the amalgamation of the American Gas Institute and the National Commercial Gas Association. In 1924 he returned to Consolidated Gas Company as vice-president in charge of commercial relations, customer service and utilization. In 1932 he was elected a vice-president of The New York Edison Company, and in 1935 he became Executive Vice-President of Consolidated Gas Company.

Ralph H. Tapscott was born in Brooklyn August 31, 1885. He went to Erasmus Hall Academy and Boys' High School and then entered the leather business, which he left two years later to complete his education. He was graduated from Union College in 1909 with the degree of B.S. in electrical engineering. Then he joined the testing department of the General Electric Company at Schenectady, being transferred the next year to the lighting engineering department, where his duties largely involved work with the New York City group of utilities.

In October, 1917, Mr. Tapscott left the General Electric Company to become assistant chief electrical engineer of The New York Edison Company. In 1925 he was promoted to electrical engineer and in 1932 became vice-president of that company and of The United Electric Light and Power Company. In 1936 he was elected vice-president of Consolidated Edison Company when The New York Edison Company, Inc., was merged into Consolidated Edison. For the last five years Mr. Tapscott has been co-ordinating the engineering, construction and operation of the electric companies affiliated with Consolidated Edison Company.

News from the Field

J. E. MARTIN, general manager of the stoker division of Link-Belt Co. announces the appointment of H. F. Brown to manage the sale of its electronic Radiostat control system for eliminating overheating and underheating. Mr. Brown, a graduate of the University of Illinois, has been associated with another stoker manufacturer for the past 4 yr. and previous to that time was in the heating contracting business.

DR. ALFRED DOUGLAS FLINN, director of the Engineering Foundation and long a leader in organized engineering, died on Sunday, March 14, at the Heathcote Inn, Scarsdale, N. Y., after a prolonged illness. His death was due to heart disease. Dr. Flinn was sixty-seven years old.

"FRAHM" VIBRATING reed tachometers are now available for speeds up to 30,000 r.p.m., according to a recent announcement by James G. Biddle Co., 1211 Arch Street, Philadelphia. These instruments have been available for many years for lower speeds but this new range adapts them not only for measuring rotational speeds of motors, turbines, etc., but also for measuring the vibrations per minute of pneumatic hammers, drills, etc.

ROLLER-SMITH Co., 233 Broadway, New York, N. Y., announces the appointment of Spring & Buckley, Inc., 77 Church Street, New Britain, Connecticut as its Agent for the State of Connecticut.

H. P. MEE, vice-president of Caterpillar Tractor Co., of Peoria, Ill., finding his interests in citrus fruit holdings in California expandng rapidly, has decided to transfer his actvities to that state and, after June 1, will be located at Santa Barbara. He has, therefore, resigned as vice-president of the company and will give up his work in supervision of sales, service and advertising.

C. F. HARDY has become a member of the fuel engineering staff of Appalachian Coals, Inc., at Cincinnati, Ohio. He is a graduate mechanical engineer of Purdue University and for 8 yr. has been connected with the power plant engineering staff of Chrysler Corp. at New Castle, Ind., designing, supervision, operation and testing of power generating and distributing systems including steam, electricity, air, gas and water. Mr. Hardy will devote his time to helping power plants to analyze their problems and select their coals.

LINK-BELT Co. has announced that four directors were elected by its stockholders to serve until 1941. The newly elected directors, Bernard E. Sunny, Chicago, and James S. Watson, Indianapolis, succeed Arthur L. Livermore, deceased, and Austin L. Adams, resigned. The re-elected directors are Staunton B. Peck, Chestnut Hill, Pa., and Harris Whittemore, Jr., Naugatuck, Conn.

THE LINCOLN ELECTRIC Co., Cleveland, Ohio, announces the appointment of Don McCormick as arc welding consultant for the Kansas City Missouri office, at 1818 Main Street. Mr. McCormick was formerly welding supervisor for the Sheffield Steel Co. of Kansas City. His work will be under the supervision of E. D. Anderson who is in charge of the Kansas City Office.

USES OF NICKEL and its alloys were discussed by F. L. LaQue of the International Nickel Co., Inc., before Detroit and New Jersey chapters of the American Society of Metals at recent meetings. Copper-nickel alloys of 20 to 30 per cent nickel are used for boiler and condenser tubes because of good strength and resistance to corrosion. Alloys with 45 per cent nickel are in favor for electrical resistance wire for starters and voltage regulators, also for architectural ornamentation. With 50 to 70 per cent nickel and 12 per cent tin, bronze alloys are employed for valve parts. For metal trim, plumbing fittings and the like, white bronzes with 8 to 30 per cent nickel and various content of copper, tin, zinc and lead are known as nickel silvers, are economical to maintain and do not peel as do plated parts.

ANNOUNCEMENT is made of the new Chicago Exposition of Power and Mechanical Engineering to be held in the International Amphitheater Oct. 4 to 9, 1937. It will be under the same management that has conducted National Power shows in New York for many years and is intended to supplement, not replace, the New York shows. The Chicago show, it is stated, will be conducted in the same manner as New York shows at the instance of leading exhibitors, and frequency of repetition will be decided after the first show has been held, although the present demand promises well for a continued future.

B. B. MORTON, speaking before the superintendents of Continental Oil Co. at Ponca City, Oklahoma, emphasized the value of steels containing 2¼ per cent nickel for large pressure vessels on account of toughness, of cast nickel steels for machine parts subject to shock and of Ni-Resist, a cast iron containing 14 per cent nickel, 2 per cent chromium and 6 per cent copper for parts liable to corrosion, scaling, warpage or growth from successive heatings. Mr. Morton is of the Research Division of The International Nickel Co., Inc.

J. B. TROTMAN, who for many years was associated with Goulds Pumps, Inc., and is widely known in the pump field, is now located at Connersville, Ind., as manager of the "T" pump division of Roots-Connersville Blower Corp.

THE JAMES F. LINCOLN Arc Welding Foundation, sponsor of the $200,000 arc welding prize contest, announces the appointment, as assistant secretary, of Edmond C. Powers who has been engaged for three years in technical writing for The Lincoln Electric Co., Cleveland, Ohio. Prior to starting work with Lincoln, he served the Penton Publishing Co., 4 yr. as associate editor of two monthly technical publications in the marine field. Practical mechanical and manufacturing experience was gained at Rolls-Royce of America, Inc., after graduation from Amherst College. In 3 yr. technical writing for The Lincoln Electric Co., his experience has touched upon every field in which the electric arc process of welding is used. During the past year, under supervision of A. F. Davis, Lincoln vice-president, and with the assistance of various Lincoln engineers, Mr. Powers edited and produced the Fourth Edition of the Procedure Handbook of Arc Welding Design and Practice.

DURING THE WEEK of April 19 to 24, the International Congress of the International Association for Testing Materials will hold a meeting in London, England. Detailed information may be obtained from the Secretary, K. Headlam-Morley, 28 Victoria St., London, S.W. 1.

ANNOUNCEMENT has been made that the 35th annual convention of the Universal Craftsmen Council of Engineers will be held at Chicago, Illinois, August 3 to 7 inclusive. Headquarters will be at the Stevens Hotel. An exhibition of power equipment displayed by manufacturers in the power field will be held in conjunction with the convention. D. W. Haering, 3408 W. Monroe St., Chicago, Ill,, is arranging the technical program.

GENERAL ELECTRIC Co. reports of business are cheering. For 1936 sales billed increased 29 per cent over 1935 and orders received were 37 per cent larger for 1936 than for 1935. Net income increased 58 per cent, due in part to larger income from investments, also investment reserve was increased, partly due to increase in value of investments by some 74 per cent, increase in earned surplus being $1,373,000.

Number of employes increased by over 6000 and average annual earnings by 8.5 per cent.

For the first 2 mo. of 1937 value of orders received increased 79 per cent over those received for the same 2 mo. in 1936 and sales billed increased 39 per cent.

FOR THE NEW air-conditioning and water-cooling plant for the capitol, senate and house office buildings in Washington, D. C., York Ice Machinery Corp. is to build six 4-cylinder Freon-12 machines driven by 1000-hp. synchronous motors, with all auxiliary equipment and piping system. Capacity of the plant will be 8000 g.p.m. cooled to 40 deg. F. Consulting engineers are C. S. Leopold of Philadelphia and G. A. Weschler of Washington.

Edward P. Rich

EDWARD P. RICH, for over thirty years prominently identified with the engineering profession in the Chicago area died suddenly at his home on April 19. Mr. Rich was born in Chicago July 16, 1879 and received his education in the schools of that city, the University of Chicago and the University of Michigan, graduating from the latter in 1903 with the degree of B.S. in mechanical engineering.

Starting as a draftsman with Pierce, Richardson & Neiler in 1903 he progressed rapidly and became a member of the firm of Neiler, Rich & Co., when it was organized in 1917 to succeed Pierce, Richardson & Neiler. Among the prominent jobs in the Chicago area engineered by the firm are: the Northwestern Station, University of Chicago and Northwestern University.

During the war he was the engineer in charge of power plants and heating at Camp Custer, Battle Creek, Mich., responsible for the design and execution of all mechanical work. He participated actively in engineering society affairs and was a member of the A.S.M.E., A.I.E.E. and W.S.E. as well as of the University Club.

Cleanest Air for Field Building

THE CLEANEST AIR in any office building in the country will be supplied this summer in the Field Building, Chicago's newest, largest and most modern office building. Already air conditioned to the extent of temperature and humidity control, the lower arcade and first four floors of this 45 story building will approach the ideal with the installation of Westinghouse electrostatic air cleaners.

Including the offices, specialty shops and restaurants on these floors, the installation will provide the most complete air conditioning and most healthful atmosphere in any commercial building. It is said the installation tends to bring relief to sufferers of hay fever and asthma as well as reduce cleaning costs to a minimum.

The air cleaning equipment will have a capacity of 272,700 cubic feet of air per minute and an efficiency of over 99 per cent of weight of particles removed from the air. Operating on an electrostatic principle the air cleaner will remove microscopic particles as small as one-fifth micron in size; will operate on a small current consumption of 10 kw. and will have a minimum of maintenance.

The air cleaning equipment will consist of eighteen units ranging in capacity from 33,000 cu. ft. per minute to 3,000 c.f.m. employing a total of 369 collector cells and 185 ionizing assemblies. The first of the units will be placed in operation by May 1, and the installation completed during July.

THE FOXBORO CO., Foxboro, Mass., has just announced the appointment to Vice Presidency of C. E. Sullivan, who has been affiliated with the company for 26 yr. and has occupied the position of Sales Manager since 1920. He has been instrumental in the rapid growth of the company and the expansion of its line to include a complete line of indicators, recorders, and controllers for temperature, flow, liquid level, pressure and humidity.

COMBUSTION ENGINEERING CO., Inc., New York, has just issued another of its series of equipment catalogs. This covers its extensive line of CE bent-tube boilers, many pages being devoted to cross-sections of typical installations of various types, photographs of furnace and boiler details and shop views.

THE BLAW-KNOX CO., through its president, W. P. Witherow, has announced the acquirement of the property and business of the Power Piping Co. of Pittsburgh.

The Power Piping Co. was organized in 1916, and has been engaged in the design, manufacture, and erection of piping for power plants, oil refineries, sewage plants, water works and industrial plant usages for all pressures and purposes. In 1934, it added a sprinkler division. In 1932, new modern fabricating machinery and bending equipment was installed to increase production. The business will now be operated under the name of Power Piping Corp., William V. Quartz will continue in charge.

ST. JOHN X RAY SERVICE, Inc., has developed a portable machine on a trailer chassis, which will penetrate 3 in. of steel on a 1 min. exposure, for use in examining welds and material in the field.

THE LINCOLN ELECTRIC CO., Cleveland, Ohio, announces two appointments to the sales staff of its Philadelphia office, 401 North Broad St. These are William Sivyer, graduate of the University of Illinois, and B. B. Ross, graduate of Kentucky Wesleyan College.

THE HAYS CORP., Michigan City, Ind., announce that the business and personnel of Carrick Engineering Co. has been taken over and will be operated as the Carrick Combustion Control Div. of the Hays Corp. There will be no change in personnel and W. H. Pugsley will be manager of the new division.

There will be few changes in the field representation as the Hays-Carrick accounts have been handled from the same office in most cities. In New York City, the Paul B. Huyette Co., Inc., 205 E. 42 St., Hays Representatives, Andrew Bittner, district manager, took over the Carrick account on March 1st and will be assisted by the L. R. Merritt Co., for many years the Carrick Representative in New York City.

THE REFRIGERATING MACHINERY ASSN. will meet May 12 and 13, at Hot Springs, Virginia, to discuss the forward-looking standardization program which the Association has undertaken and on which substantial progress has been made during the past year.

THE AIR CONDITIONING MANUFACTURERS' ASSN. will hold its annual meeting at Hot Springs, Virginia, May 14 and 15, as announced by president J. F. G. Miller. The past year has been one of excellent progress and remarkable growth. The Association is planning an even broader program of constructive work for the year.

THE NATIONAL BOARD of Boiler and Pressure Vessel Inspectors will hold its Eleventh General Meeting at the Hotel McAlpin in New York City on May 24, 25 and 26. This Board was organized in 1919 for the purpose of securing uniform approval of specific designs of boilers and pressure vessels through the adoption, by various states and cities, of one code of rules and of one standard stamp to be placed on boilers and pressure vessels constructed in accordance with such rules. There will be morning and afternoon sessions on each of the three days. All of the sessions will be open to those interested; registration will be required but there will be no charge therefor. Major changes in the construction and design of boilers and pressure vessels are being made, together with the development of new materials contemplated in their construction, and these changes and new materials are the basis on which the program for this meeting has been developed. The subjects to be discussed are of utmost importance and interest to engineers, manufacturers and operators of these vessels and the papers will be presented by foremost authorities on the various subjects.

WILLIAM K. CLOW, Jr., formerly general manager of the Henszey Co., Watertown, Wis., has become identified with the technical staff of the Elgin Softener Corporation, Elgin, Ill. He is widely known in the field of water conditioning especially for steam power plants, and will specialize in the field of boiler water conditioning.

HOMESTEAD VALVE MANUFACTURING CO., Hypressure JENNY Division, announces the appointment of the following distributors for handling exclusively its line of chemical vapor spray cleaning machines: Toledo Equipment & Supply Co., 1007 Jefferson Ave., Toledo, Ohio; Oil Burner Equipment Co., 504 Lafayette St., Tampa, Florida; Merkel & Roberts, 478 E. Erie St., Painesville, Ohio; and Gleasner Corporation, 217 Leroy Ave., Buffalo, New York.

ANNOUNCEMENT has been made that Alfred Iddles has become associated with The Babcock & Wilcox Co. in the Engineering Department. He will assist E. G. Bailey, Vice President in charge of engineering, and will have charge of application engineering and service work. Until recently Mr. Iddles was Executive Vice President of United Engineers & Constructors, Inc., in Philadelphia and prior to that time was with Day & Zimmerman in Philadelphia in various capacities, as Power Engineer, Chief Engineer and Vice President. He is well-known in the Power field, having been associated with many developments in both industrial and central station plants. As a Fuel Engineer in the Bureau of Mines he assisted in completing the Government tests on the Emergency fleet boilers and development of mechanical oil burners for marine service. At that time he was in charge of the first tests made by the Bureau on pulverized coal installations. This was a unit pulverizer using the direct fired method, a system which is now much in favor in most plants using pulverized coal as fuel.

For the Engineer's Library

DIESEL HANDBOOK by Julius Rosbloom. Published by Diesel Engineering Institute, 443 Hoboken Ave., Jersey City. Size 5x7 in. Flexible fabricoid cover, 708 pp. Price $5.00.

As a book intended to give the Diesel operator a complete picture of Diesel engine design, construction and maintenance in simple language, the chapters have been carefully arranged and the material presented in two parts to give a logical development. Part I deals with the general principles and theories of heat power, characteristics of liquids, oil and transformation of liquids into gas, compressor theory and practice, and modern metallurgy.

Part II is a general explanation of the Diesel engine theory and operation, detailed operating directions, typical installations, hints on maintenance, useful tables and conversion factors. The Diesel engine of today is highly perfected and technical problems have been well solved. As the author points out in the preface, however, the success of an engine installation depends upon the operator who must combine practical knowledge with general theory. With this in mind, the author has produced a book correlating these two with a minimum of mathematics for the operating man.

AIR CONDITIONING-INSULATION. By J. Ralph Dalzell and James McKinney. Published by American Technical Society, Drexel Ave. at 58th St., Chicago, Ill. Size 5½x8 in., cloth bound, 295 pages. Price $2.50.

Although this book has been written primarily from the standpoint of reducing heat losses from buildings, it covers in brief form all insulation including prevention of loss by fire, control of sound, vibration prevention, protecting buildings against termites, protecting mechanical parts against heat loss by freezing and prevention of condensation. It starts with a complete review of the physics of insulation and proceeds through a discussion of the various insulations available today in commercial form.

Use of insulation is well illustrated by photographs and drawings showing typical constructions, and the last part of the book deals with the calculation of heating and cooling loads and transmission coefficients which is facilitated by complete tables and by examples worked out in the text. Although the greater portion of the book refers specifically to the application of insulation to residences, the complete and thorough treatment will be found valuable to all architects and engineers concerned with this problem from an industrial standpoint.

STEAM BOILERS. By Terrell Croft, and revised by R. B. Purdy. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York, N. Y. Size 5½ by 8 in., cloth bound, 404 pp. Price $4.00.

This is the second edition of a book originally published in 1922 and intended to serve the needs of those preparing to pass engineers' license examinations. Due to the progress that has taken place in boiler room practice since that time, much of the material has been revised in the second edition, additional material on steam dryers, washers, water walls and superheaters added and the book made to conform with the 1933 A.S.M.E. Boiler Construction Code. The author's original style has been followed in the revision and the "man of little schooling" for whom the book was primarily intended has not been lost sight of. It is divided into 26 chapters or divisions, ranging from the function, classification and evolution of steam boiler to its construction, auxiliaries, testing and selection. Mathematics beyond simple arithmetic are omitted, the explanations are clear and complete and give the practical man not only information that will be of direct use to him but sufficient background to enable him to understand the whys and wherefores of certain designs and trends.

TWO STEAM CHARTS of interest and value to engineers and students of thermodynamics have recently been prepared by Professor Cho-Lan Yin, Dept. of Mechanical Engineering, National Tsing Hua University, Peiping, China. Based on the Keenan A.S.M.E. steam tables, they are printed on serviceable paper, 21 by 29 in. and fold in the pocket of a small booklet. This booklet explains the relation of the respective charts to the temperature-entropy, Mollier Diagram, etc., and illustrates their use by the solution of several representative problems.

The first is a pressure entropy diagram, particularly useful in the superheated steam range where poor intersections on the temperature-entropy chart makes numerical values of doubtful value. The second is the Internal Energy-Pressure diagram. Internal energy differs from the more commonly used total heat value by the external work done due to volume changes. At ordinary pressures the difference in the two values is small but at high pressures the difference is appreciable. Those interested may obtain the charts direct from Professor Yin or from this office where a limited number are available for the convenience of subscribers. The price is 30 cts. per chart to cover the cost of postage and printing.

ELECTRICITY. By W. L. Bragg. First Edition. 272 pages, illustrated with numerous plates and diagrams, size 6 by 8½ in., cloth. The Macmillan Company, New York, N. Y., 1936. Price $4.00.

Electricity is a strange thing, universally existent, of incalculable value to mankind, the driving force, probably, of the universe, yet it is the one thing most people in this world know less about than almost anything else one can think of. Take, for example, such a complicated business as stamp collecting, with its fine technical points about perforations, grouping, the shape of Napoleon's nose on a spurious issue of French two centers and we can point to thousands of people who know all about it. Take the equally complicated matter of horse racing with its strange jargon about parlays, long shots, mutuals, etc., or the infinitely more complicated subject of the Constitution or the Supreme Court and we will show you millions of people who will sit up all night discussing these subjects whether they know anything about them or not.

But take such a simple thing as "electricity"—something which has only two basic elements and we will show you some two billion people in this world whose minds freeze up when the subject is mentioned. "Electricity! Gosh, that's a mystery—nobody knows what electricity is."

Ask these same people what heat is and they will tell you. Ask them to explain their image in a mirror and they will tell you all about it. But don't ask them why their electric toaster gets hot when the current is switched on; that's a mystery—that is electricity.

Perhaps there is some excuse for this state of affairs. As the author of this book says, "Nature has not prepared us to study electricity. . . . The instincts and common sense which we acquire by handling objects make it comparatively easy for us to understand heat and light and sound and the way in which machines work, but we seem to have no corresponding natural electrical sense, although electrical devices play so important a part in our lives."

Here, however, we have a book which can do much to remove this disability. Written by one of England's foremost physicists, a recipient of the Nobel Prize and many other honors, it explains in simple terms and in a delightful way, the fundamental nature of electricity. He shows how it travels, how motors, cells and dynamos operate, how our transmission systems are made up. For young or old, for the electrical engineer or the layman, this book is bound to provide interest.

A NEW CATALOGUE on Single-Stage, Type FS Motorblowers has just been issued by Ingersoll-Rand, 11 Broadway, New York City. This bulletin, form 2161-A, features an illustrated discussion of the theory of centrifugal air compression to pressures up to 3 lb., and also contains an illustrated section covering the seven major fields of Motorblower applications.

THE ENGINEERING EXPERIMENT STATION of Ohio State University has announced the release of a new handbook for the construction of Nomographic Charts. The book, written by Dr. Paul N. Lehoczky of the university's Department of Industrial Engineering, is titled: "Alignment Charts. Their Construction and Use."

Purpose of the book is to teach the reader to construct a simple type of chart for any type of equation, no matter how involved, and to do this without the necessity of a theoretical background other than algebra. The method employed is called "kitchen recipe" because it presents the material in that fashion without going into the theory.

COMPLETE SPECIFICATIONS covering all types of coal tar pitch and tarred felt roofings with construction sketches are given in a new bulletin by the Tar and Chemical Division of Koppers Company, Pittsburgh, Pa.

SPECIFICATIONS and engineering data on the CE-Skelly stoker unit for small commercial and industrial installations are contained in a new catalog issued by Combustion Engineering Co., Inc., 200 Madison Avenue, New York. These stokers are built in the stationary-grate type for coal burning capacities up to 300 lb. per hr. and in the moving-grate type for capacities up to 2000 lb. of coal per hr., for either anthracite or bituminous coal.

TECHNICAL BULLETIN No. 10, just issued by the Steel and Tube Division of The Timken Roller Bearing Co. presents data on oxidation at 1000, 1250 and 1500 deg. F., on thirteen different steels. This bulletin will be of particular interest to designers and operations confronted with oxidation problems connected with cracking coils, polymerization plants, superheaters, high-pressure steam plants, air heating equipment and recuperators. Copies may be secured upon request to the Steel and Tube Division of The Timken Roller Bearing Co., Canton, Ohio.

A NEW FAIRBANKS-MORSE BULLETIN (No. 1600) describes that company's line of polyphase wound-rotor or slip-ring, ball-bearing, induction motors. The high starting torque characteristics of these wound-rotor motors it is claimed make them ideally suited to applications where the relatively high starting current of squirrel cage motors would be objectionable—in driving high-inertia, slow-starting loads, or where the size of motor required is relatively large with respect to the power supply.

WHICH END, a booklet published by Appalachian Coals, Inc., Cincinnati, Ohio, has had a distribution of some 100,000 copies in the central west. It gives helpful hints on smokeless firing, especially of household furnaces, and describes the alternate firing method to avoid making smoke and increase efficiency of combustion and heat absorption.

SOME CONSEQUENCES of Graphite Corrosion of Cast Iron is the title of a pamphlet issued by The International Nickel Co., Inc., New York, N. Y., which will be supplied on request to the Company. It deals with the local galvanic effects between graphite coatings and underlying metal and the dependence of formation of protective coatings on the size and distribution of the graphite particles, which seems to be favorable in nickel alloy irons and to retard corrosion.

BULLETIN No. 600 just issued by the Elgin Softener Corp., Elgin, Ill., describes its two-flow softener in which the hard water enters at the bottom of one tank, flows up through the zeolite and over through a pipe line to the top of the second tank, thence down through the second zeolite bed and out of the bottom of this second tank as zero soft water.

FACTS about the manufacture, use and properties of plywood are given in a bulletin published by the Douglas Fir Plywood Association, Tacoma Bldg., Tacoma, Wash.

PURDUE UNIVERSITY, Lafayette, Ind., has issued Extension Series No. 36 which is a report of the foremanship training program in Indiana industries as carried on from 1919 to 1936. Three types of groups have been organized in this foremanship training program: Conferences with factory foreman and others having direct responsibility for the supervision of employes; leadership conferences intended for individual leaders who will later conduct foremanship meetings in their respective plants or departments; foremanship conferences intended for the supervisory personnel in the Civilian Conservation Corps camps of Indiana. The report, which was prepared by Professor G. F. Buxton, outlines the general scheme followed throughout the years and lists the industries served in this activity of the University.

A-E-CO LO-HED Hoists are treated in an attractive bulletin published by American Engineering Co., Philadelphia, Pa. These hoists have many applications in industry and the bulletin is prepared to assist purchasers in selecting the most suitable type of equipment.

BULLETIN A-209, issued by the Dodge Manufacturing Corp., Mishawaka, Ind., is devoted to a description of the manufacturing processes employed in making the Dodge "D-V" drive which is a V-belt system. The bulletin contains a great amount of technical data and numerous tables to aid in the selection of the proper equipment.

SIMPLEX oil burners of the horizontal rotary type are described in bulletin 119-37 recently issued by Simplex Oil Heating Corp., 30 Church St., New York City, a table of sizes and capacities is included.

CANTON STOKERS insured for five years is the subject of a bulletin recently issued by the Canton Stoker Corp., Canton, O., which in addition to descriptions of the corporation's ram type underfeed, worm type underfeed and natural draft overfeed stokers contains a copy of the five year insurance contract.

HASLER-TEL CO. of New York City is sending a folder describing its speed indicator, which, by a stop watch mechanism, automatically runs for 3 sec. after the button is pressed and indicates the r.p.m. A second button resets to zero. By a disc attachment, applied to the spindle and held against a pulley rim, the rim speed in ft. per min. will be shown on a special scale.

BIJUR automatic lubrication is described and illustrated in a catalog of the Bijur Lubricating Corp., Long Island City, N. Y.

THE DEPENDABLE DIESEL is the title of an attractive and interesting booklet from The Cummins Engine Co., Columbus, Ind., which shows the application of its product to land and marine transportation, to tractors, to portable and stationary power plants and to special emergency situations. It is especially convenient in form and gives a comprehensive idea of the wide diversity of uses to which Diesel engines have been adapted and in which the Company's product has been utilized.

BULLETIN No. 290 "Investigation of Summer Cooling in the Warm-Air Heating Research Residence," by Alonzo P. Kratz, Maurice K. Fahnestock, and Seichi Konzo, which has just been issued by the Engineering Experiment Station of the University of Illinois, Urbana, Ill., presents a report of the results obtained in an investigation of summer cooling carried on during the summer seasons of 1932, 1933, and 1934, in the Warm-Air Heating Research Residence in Urbana, Illinois.

CONSTRUCTION AND APPLICATION of Enco Baffle Walls to modern boilers and for the modernization of existing plants are covered in detail in Bulletin B-37 of The Engineer Co., 17 Battery Place, New York City. A large number of typical straight tube and bent tube installations are shown in this 16-page bulletin.

CORNELL IRON WORKS, Inc., 36th Ave. and 113th St., Long Island City, New York, has just published a new 12-page general catalog entitled, "Modern Cornell Doors-Upward Acting." The catalog describes and illustrates with details and photographs the Cornell upward acting doors and grilles. Actual installations are featured and unusual applications are shown.

ALLIS-CHALMERS MFG. CO., Milwaukee, Wis., has issued a new Blower and Compressor Bulletin, No. 1910, intended to show briefly all the types made by that company. These include centrifugal, rotary and reciprocating units which can be furnished complete with their prime movers, whether electric motors, steam turbines, or steam engines, for all ordinary applications involving air or gas.

WESTINGHOUSE FLEXARC motor driven welders and bare generators are described in a recent publication. Application, construction, specifications and performance curves for single operator 200, 300 and 400 amp. welders are included.

ALLIS-CHALMERS MFG. CO., Milwaukee, Wis., has issued leaflet 2247 on their new "Utah" electric-magnetic vibrating screen which has no rotating parts and operates on a new principle that uses alternating current.

SCOVILL MANUFACTURING CO., Waterbury, Conn. has recently issued a very attractive 48 page booklet entitled Scovill Condenser Tubes. From the standpoint of presentation and attractiveness this booklet is as fine an example of printing as we have seen anywhere. It presents a clean, unbiased description of the methods of production, the various alloys available and contains recommendations as to the type of service to which each alloy is most economically adapted. It contains sections on extruded tubes, tubes produced by hot piercing, and tubes made by the Cup

Drawing process. Each section is described and completely illustrated to show the appearance of the material at various stages and the type of equipment used in each process.

Sections have also been included to give a quick reference to the composition and physical properties of condenser tube alloys; a 6-page general specification section, and an illustrated section on tube installation methods and installation tools.

THE DIRECT SEPARATOR CO., Syracuse, N. Y., has recently issued Catalog EJ-37, which describes the direct internally and externally guided expansion joints which are kept in line by what is known as a balanced design. The bulletin contains information on how to figure the amount of expansion in pipe lines, and other data to aid in the selection of the proper size expansion joint.

PLANT FACILITIES and past experience in the fabrication of special processing equipment for industrial plants is featured in a new 8 page Products Bulletin No. 103 just issued by Edge Moor Iron Works, Inc., Edge Moor, Del.

BUILDING A CAREER in Arc Welding, a practical course of instruction given at the Lincoln welding school of the Lincoln Electric Co., Cleveland, Ohio is fully outlined and the work illustrated in a 12-page booklet which describes courses, textbooks and methods. Where a number of men are interested, local classes can be arranged either for a region or for a plant.

MICROMAX CO_2 recording equipment for flue-gas analysis using saturated gas and the thermoconductivity method, is described in a new bulletin N-91-163 just issued by Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.

WIDE RANGE CONTROLOGRAPHS for controlling temperature and pressure regulation is described in a new four page bulletin issued by the American Schaeffer & Budenberg Division of the Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn. This device is non-indicating but is made in both recording and non-recording types.

CATALOG No. 37 issued by Watts Regulator Co. of Lawrence, Mass., covers the company's complete line of relief valves, pressure regulators, low water cutoffs, boiler water feeders, hot water heating systems and hot water heating regulators.

NON-INDICATING temperature and pressure controls as made by C. J. Tagliabue Mfg. Co., Park and Nostrand Aves., Brooklyn, N. Y., are described in detail in a new 32 page catalog No. 900C illustrated by drawings and photographs.

DUPLEX, self-oiling pumps for handling mud and slush, clear water, petroleum products and other liquids are described in a new bulletin No. 6165 issued by Fairbanks, Morse & Co. These pumps are available in capacities from 23 to 94 g.p.m. at pressures up to 475 lb. per sq. in.

CENTRIFUGAL FAN unit heaters are described in a new catalog issued by the Airtherm Manufacturing Co., 1474 S. Vandeventer, St. Louis, Mo. This air heater is composed of a bank of extended fin U bend coils through which air is drawn by multi-blade fans and is built in a number of sizes applicable to all types of industrial space heating.

PANORAMA OF LUBRICATION is the title chosen by Shell Petroleum Corp., St. Louis, Mo., for a series of booklets on manufacture and application of lubricants giving information in non-technical form. The first three are now available on, the Fundamentals of Lubrication, Lubricating Friction Type Bearings, and Golden Shell, the Modern Oil. Any or all of them may be obtained at the Shell Co.'s sales offices or by writing to the home office to have your name put on the mailing list. They are interesting reading as well as giving a clear explanation of the subjects treated.

DARDELET self-locking bolts and nuts are described and illustrated in a folder of the Dardelet Threadlock Corp., New York, N. Y.

A NEW LINE of Westinghouse Miniature Instruments for all types of industrial and radio applications are described in a catalog section announced recently. Included in the publication are applications, construction, operation, outline dimensions, wiring diagrams, ratings and list prices for all types of miniature instruments. Copies of the catalog may be obtained from the nearest district office or direct from Department 5-N, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

JAMES G. BIDDLE CO., 1211 Arch St., Philadelphia, has just issued Bulletin 1495 describing their new "Megger Circuit Testing Ohmmeter."

This is a genuine "Megger" of the cross-coil type that is independent of the voltage of the operating battery. It has the ruggedness, accuracy and reliability of "Megger" instruments and has already been welcomed by the more discriminating type of engineer and electrician who likes to use really fine instruments and also who objects to the voltage adjustment of the ordinary voltmeter-type ohmmeter.

A PUBLICATION entitled Cubicle Type Switchgear for indoor service with manually or electrically-operated breakers has been announced by the Westinghouse Electric & Mfg. Co. Completely factory assembled for installation, the Cubicles are available in sizes from 200 to 2,000 amp., 2500 to 15,000 v. with interrupting ratings from 20,000 to 500,000 kv-a. For use in central station main and auxiliary circuits, steel mills, industrial plants and distribution substations providing control for motors, generators, incoming lines and feeders, the publication describes the construction, features, accessories, dimensions, connections and ratings of these units.

THE WEBER CHIMNEY CO, McCormick Bldg., Chicago, Ill., has recently published an interesting bulletin under the title Chimney Maintenance, which describes a number of defects to which concrete chimneys are subject and the company's methods of dealing with these maintenance problems.

THE RELIANCE GAUGE COLUMN CO., 5902 Carnegie Ave., Cleveland, Ohio, has recently issued an attractive bulletin illustrating and describing the Reliance Eye-Hye remote reading liquid level indicator for use on boilers.

DESIGN AND CONSTRUCTION details of extraction heaters are covered in a new 12 page bulletin, No. 277 issued by The Griscom-Russell Co., 285 Madison Ave., New York, N. Y.

THE NEWARK WIRE CLOTH CO., Newark, N. J., has recently issued a small folder which illustrates and describes the "End-Shak" Testing Sieve Shaker. The folder tells how the End-Shak machine imitates but improves hand testing and contains considerable valuable information on Newark USS-ASTM testing sieves, the importance of accuracy, features of the U. S. Standard series, how sieves are graduated, and a table of sizes, code words and prices.

DETROIT STOKER CO., General Motors Bldg., Detroit, Mich., has recently issued a 24-page catalog devoted to the use of Detroit stokers in prominent educational institutions, including private and parochial schools, colleges, universities and public schools in many cities of the United States and Canada.

THE BROWN INSTRUMENT CO., Philadelphia, Pa., has just published a new catalog on Brown Flow Meters. This new catalog (No. 2004) covers the complete line of Brown Flow Meters—Indicating, Recording and Integrating—in both Electrical and Mechanical Types—together with Brown Air-o-Line Flow and Liquid Level Controllers. It explains their application to Power Plant, Water Works and Gas Generation service, as well as to general industrial use. It describes in simple, non-technical language the operation and construction of both Electrical and Mechanical types of Brown Flow Meters—the Inductance Bridge Principle—the features of Brown Electric Meter Bodies for use on working pressures as high as 5000 lbs. per sq. in. and as low as 50 lbs. per sq. in., and many other Brown devices. A copy of the catalog will be sent to anyone writing The Brown Instrument Co., Wayne and Roberts Ave., Philadelphia, Pa.

QUIGLEY CO., New York City, is distributing two folders, one on its heavy duty black paint for protecting metal structures, the other on Insulblox refractories for furnaces and for exterior heat insulation.

FLUID METERS for steam, liquids, gases, designated as Bulletin 301, is being distributed by Bailey Meter Co., Cleveland, Ohio. It illustrates the manner in which any desired combination of indicating, recording and integrating features may be combined with a flow mechanism suitable for the measurement of steam, liquids or gases under high, low or medium pressures.

J-METAL cutting tools of Haynes Stellite are described in a 52-p. booklet issued by Haynes Stellite Co., Kokomo, Ind.

PORTABLE COMBUSTION Testing Instruments are made the subject of Publication No. 37-253 recently issued by The Hays Corp., Michigan City, Ind. This attractive bulletin illustrates and describes such instruments as flue gas analyzers, portable draft gages, flue gas thermometers, combustion test sets and B.t.u. calorimeters.

IN A CATALOG recently issued by the American Schaeffer & Budenberg Division of Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn., the various types of American Glass Thermometers are illustrated and described. These thermometers have red reflecting glass, which makes the mercury appear to be red and makes them easy to see, which is a great aid to accuracy. The use of monel metal for the bulb chamber makes them rust proof and corrosion resistant.

Power Plant Construction News

Ala., Cherokee — Cherokee County Electric Membership Corporation, Cherokee, plans new steam-electric generating plant in connection with rural electrification project. Station will cost close to $85,000. Fund of $310,000 has been secured through Federal aid for entire project.

Calif., Los Angeles—Cudahy Packing Co., 803 Macy Street, plans installation of electric power equipment in new four-story addition to local meat-packing plant. Entire project will cost in excess of $200,000, including improvements in present plant. Main offices of company are at 221 North La Salle Street, Chicago, Ill.

Calif., Los Angeles — General Petroleum Corporation, Higgins Building, plans installation of power equipment, pumping machinery, boiler plant and other mechanical equipment in proposed new gasoline refining plant in Ford Avenue district, Wilmington, Los Angeles. Entire project will cost close to $350,000

Ga., Valdosta—Glidden Co., Berea Road and Madison Avenue, Cleveland, Ohio, plans installation of electric power equipment in new paint and varnishing-manufacturing plant at Valdosta where site has recently been acquired. A boiler house will be built. Entire project will cost about $200,000.

Ill., Chicago—Acme Steel Co., 2840 Archer Avenue, plans installation of electric power equipment in new additions to plant in Riverdale district. Work is scheduled to begin soon. Entire project will cost close to $1,000,000. F. S. Hynes is company engineer.

Ill., Chicago—Carnegie-Illinois Steel Corporation, 208 South La Salle Street, has approved plans for new steam-electric power plant at South Works, East Eighty-ninth Street, and will proceed with work at early date. Cost reported over $300,000, with equipment. A power substation unit also will be built for service at mill.

Ill., Springfield—City Council, City Hall, is arranging early call for bids for extensions and improvements in municipal power plant, including installation of new steam-generating equipment and auxiliaries. Cost about $180,000. Burns & McDonnell Engineering Co., 107 West Linwood Boulevard, Kansas City, Mo., is consulting engineer.

Iowa, Maquoketa—City Council has plans under way for extensions and improvements in municipal electric power plant, including installation of additional equipment for increased capacity. Cost about $95,000. Financing has been secured through Federal aid.

La., Baton Rouge—Solvay Process Co., 40 Rector Street, New York, N. Y., plans installation of electric power equipment in new chlorine and chemical works at Baton Rouge where site has been selected, comprising several one and multi-story units. A power house will be built. Entire project is reported to cost close to $1,000,000.

La., New Orleans—Continental Can Co., 521 North Scott Street, plans installation of electric power equipment in new one-story addition to local plant, for which superstructure is scheduled to begin in May. Entire project will cost close to $150,000. Favrot & Reed, Nola Building, New Orleans, are architects. Main offices of company are at 100 East Forty-second Street, New York, N. Y.

Mich., Comstock—Consumers Power Co., Jackson, Mich., has concluded arrangements for purchase of tract of land on Kalamazoo River, near Comstock, as site for new steam-electric generating plant, to be known as the Bryce E. Morrow Station. New station will have initial capacity of close to 100,000 hp., with ultimate output of about 275,000 hp. Cost over $5,000,000. It is scheduled for completion in June, 1938.

Mich., Kalmazoo—Kalamazoo Vegetable Parchment Co., Parchment district, Kalamazoo, plans installation of electric power equipment in new addition to paper mill, on which work is scheduled to begin at once. Entire project will cost over $250,000. M. C. J. Billingham, Kalamazoo, is architect and will supervise erection.

Mo., St. Louis—Owens-Illinois Can Co., Ohio Building, Toledo, Ohio, plans installation of electric power equipment in new multi-unit can-manufacturing plant at St. Louis where tract of land is being secured. A power house will be built. Entire propect will cost close to $500,000. Francisco & Jacobus, 511 Fifth Avenue, New York, N. Y., are architects and engineers.

Neb., Lincoln—Water Bureau, City Hall, plans extensions and improvements in municipal power plant and waterworks station at Twenty-ninth and A Streets. Cost over $135,000. Bids will be asked soon. Black & Veatch, 4706 Broadway, Kansas City, Mo., are consulting engineers.

Neb., York—Iowa-Nebraska Light & Power Co., Lincoln, Neb., plans expansion and improvements in steam-electric generating plant at York, including installation of additional equipment. Work will begin this spring. Cost close to $100,000, including equipment.

N. J., Soho—Board of Essex County Freeholders, Hall of Records, Newark, N. J., has plans maturing for new steam-electric generating plant at hospital at Soho estimated to cost about $180,000 with electric generator unit, boilers and accessories. Epple & Kahrs, 17 Washington Street, Newark, are architects; Runyon & Carey, 31 Fulton Street, Newark, are consulting engineers.

N. C., Kinston—City Commission has authorized a bond issue of $75,000, proceeds to be used for extensions and improvements in municipal electric power plant, including installation of equipment.

Ohio, Bluffton—Central Ohio Light & Power Co., Findlay, Ohio, has plans under way for new steam-electric generating plant at Bluffton, and proposes to begin work at early date. Cost about $1,200,000. Financing in that sum is being arranged.

Ohio, Cincinnati—Cincinnati Shaper Company, Garrard and Hopple Streets, plans installation of electric power equipment in new one-story addition to machine tool works. Entire project will cost close to $75,000. Work on superstructure will begin soon. Three electric traveling cranes will be installed.

Ohio, Dayton — Standard Register Co., Campbell Street, plans installation of electric power equipment in new one and two-story addition, 150x180 ft., to autographic register-manufacturing plant. Proposed to begin work soon. Cost about $150,000. Austin Co., 16112 Euclid Avenue, Cleveland, Ohio, is engineer and building contractor.

Ohio, Lorain—Ohio Public Service Co., Hanna Building, Cleveland, Ohio, has plans under consideration for new steam-electric generating plant in vicinity of Lorain. Cost close to $3,500,000 with turbo-generator units, high-pressure boilers and auxiliary equipment. Completion is scheduled in 1938.

Ohio, Painesville—Industrial Rayon Corporation, West Ninety-eighth Street and Walford Avenue, Cleveland, Ohio, has plans maturing for new multi-unit rayon mill on site near Painesville acquired a few months ago, and will take bids soon on general contract. Electric power equipment will be installed for operating services. A steam-electric power plant will be built for mill requirements. Entire project will cost about $7,500,000. Wilbur Watson & Associates, 4614 Prospect Avenue, Cleveland, are architects and engineers.

S. D., Beresford—City Council has plans maturing for extensions and improvements in municipal electric light and power plant, including installation of additional equipment. Fund of about $55,000 has been arranged for project. J. M. Engberg, Madison, S. D., is consulting engineer.

Texas, Dumas—Illinois Zinc Co., 332 South Michigan Avenue, Chicago, Ill., plans installation of power equipment, furnaces and other mechanical equipment in new addition to smelting plant, near Dumas. Capacity of plant will be doubled. Entire project is reported to cost in excess of $500,000.

Texas, Gladewater—Great American Oil Corporation, Slattery Building, Shreveport, La., plans installation of power equipment, pumping machinery and other mechanical equipment in new addition to gasoline refining plant at Gladewater. Work scheduled to begin soon. Entire project will cost close to $200,000.

Va., Manassas—Bull Run Power Co., plans extensions and improvements in local power plant, including installation of additional equipment. Company has arranged fund of $86,000 for this and extensions in power lines for rural electrification. Work is scheduled to begin soon.

Wash., Tonasket — Northern Gold Co., Tonasket, plans installation of electric power equipment in new milling plant at local gold-mining properties, with capacity for handling about 500 tons of ore per day. Entire project will cost over $175,000. A. H. Perkins is president and manager.

Wis., Madison — Crown Can Co., Eastern Avenue and Kresson Street, Baltimore, Md., a unit of Crown Cork & Seal Co., same address, plans installation of electric power equipment in new branch can-manufacturing plant at Madison, where industrial property has been acquired at 1402 East Johnson Street, and will be remodeled and equipped at early date. Entire project will cost about $250,000.

Wis., Milwaukee—Pittsburgh Plate Glass Co., 235 East Pittsburgh Avenue, Paint Division, plans installation of electric power equipment in new addition to local plant for varnish and resin departments. Entire project will cost about $185,000. Main offices of company are in Grant Building, Pittsburgh, Pa. E. D. Griffin is general manager at Milwaukee plant.